$9.30 08/11M
MRS CAROL A SZEKEY
Ph: 9435 5320
SILICON CHIP
KEEP IN
15 11
NET
top
201001031540
Mentioning Newsagency
270711 1

SILICON CHIP

AUGUST 2011
ISSN 1030-2662
08
9 771030 266001
PRINT POST APPROVED
- PP255003/01272
$9.30* INC GST NZ$11.90 INC GST

Fun projects to build

Electronic Stethoscope

Is your heart still beating?

Digital Spirit Level

It's accurate to 0.1°

WE REVIEW

Hakko Fume Extractor

Avoid those OHS Problems!

WE REVIEW

UP! Desktop 3D Printer

Affordable and Convenient 3D

WE REVIEW

New Asus "Transformer" Android Tablet:

What's all the fuss about?

August Deals HOT

August 2011

HOT DEAL
LOOK out for this icon & SAVE!

UNIVERSAL LAPTOP POWER SUPPLIES

Comprehensive range of replacement laptop power supplies that are mains operated or can be plugged into a car cigarette lighter socket. Check in store or on the web for full range and compatibility with your laptop. Here is one of our best sellers and voted PC User Best Buy for August 2011!

70W Universal - Automatic Laptop Power Supply

- Power output: 70W
- Output voltages: 8.4 - 24VDC
- Output voltage selection: Automatic
- Plugs: 16
- Dimensions: 110(L) x 52(W) x 25(H)mm

MP-3320

$59.95

WALL PLATE HDMI & IR EXTENDER

A neat and simple wall plate HDMI extender kit. This kit extends high definition AV source from Blu-ray DVD Players, PS3® and XBOX® etc. up to a maximum 100m via CAT5 / 5e / 6 cables through the wall cavities. Supports full 1080p high definition of up to 30m. Integrates an infra-red control extender for full control from the receiving end. RJ45 connections on the rear of each unit makes for easy connection.

- CAT5 / 5e / 6 cable compliant
- HDMI 1.3 compliant
- Supports up to true HDMI (1080p)
- Transmission Range: 100m (480i, 576i, 480p, 576p) 70m (720p, 1080i), 30m (1080p)
- Mains power supply included
- Dimensions: 115(H) x 70(W) x 32(D)mm

AC-1659

NEW 2011

$169.00

HDTV AV DISTRIBUTION HUB - OVER CAT5

Distribute high definition component video or standard definition composite video as well as stereo audio via Cat 5 cables to up to four different locations in your home or building. It has a built-in infrared extender to allow full control in any part of the house. This unit is expandable by connecting another distribution unit through the Loop-out output for larger scale applications. A truly powerful, versatile and cost effective home theatre distribution solution.

- Dimensions: 158(L) x 68(W) x 72(H)mm

QC-3687 WAS $299.00

$249.00 SAVE $50.00

HOT

Additional CAT5 receiver

QC-3688 WAS $129.00 NOW $99.00 SAVE $30.00

2-ZONE WIRED ALARM KIT

Simple two zone, two wire alarm for small to medium size premises. Includes one passive infrared sensor for large areas and a reed switch for one entry point such as a door or window. It has visible deterrent of an external siren box and additional sensors can be added if required. Easy to use and install with all fixings included.

- Kit includes: 1 x 2-Zone control unit, 1 x PIR sensor, 1 x Reed switch, and 1 x 25m cable

LA-5480

$99.00

HOT DEAL
FREE extra PIR Sensor (LA-5481) valued at $24.95 with every purchase!

FOR THE DJ

8-Channel Compact Mixing Console with Digital Effects

The ideal small mixer for home recording, small PA systems etc. This is a well-featured unit with high and low mic inputs, separate EQ, gain and pan controls, aux send and return for effects, recording outputs and phantom power (48V).

- Four mono channels with high & low impedance inputs
- 2-band EQ on all mono channels
- 2 stereo channels
- LED master level indicator
- Headphone output with separate level control
- Sturdy metal construction
- Dimensions: 270(W) x 270(H) x 50(D)mm

AM-4204

$299.00

HOT DEAL
Buy both for $300 SAVE $23.95

LED Gooseneck Mixing Desk Light

No DJ or engineer should be without one of these. Plugs into any XLR microphone socket and provides enough light to see what you're doing without disturbing the audience.

- LED
- Runs on phantom power
- Flexible gooseneck
- 400(H)mm

AM-4124

NOTE: Mixing console not included

NEW 2011

$24.95

LED MODULES & ACCESSORIES

LED Driver Power Supplies

These tiny LED drivers are designed to run modern high power LEDs and are perfect for our CREE® and Edixeon range. They come fully encapsulated for improved environmental protection. Four models are available:

FROM $9.95 & SAVE $$$

AA-0590 shown

3VDC 1-2 LEDs

AA-0590 WAS $15.95 NOW $9.95 SAVE $6.00

9-30VDC 1-6 LEDs 1W

AA-0592 WAS $19.95 NOW $14.95 SAVE $5.00

9-30VDC 1-6 LEDs 3W

AA-0594 WAS $24.95 NOW $19.95 SAVE $5.00

12-30VDC (dimmable) 1-3 LEDs

AA-0596 WAS $24.95 NOW $19.95 SAVE $5.00

CREE® XP-G High Power LED & Collimator Lenses

Super bright, efficient LEDs, which have a life expectancy of over 50,000 hours. A myriad of applications including architectural lighting, mood lighting, display cabinet lighting, DIY torches, or any other lighting project. Power using the LED driver power supplies shown above. Lens sold separately. See website for full specifications.

NEW 2011

CREE® XP-G LEDs

- Over 430 lumens @ 350mA
- Viewing angle w/o lens: 125°
- Dimensions: 10(Dia)mm

FROM $17.95

White	ZD-0445 $17.95
Warm White	ZD-0447 $19.95

Collimator Lens to suit

- Dimensions: 10(Dia) x 9(H)mm

13° Narrow Angle	HP-1282 $6.95
24° Wide Angle	HP-1284 $6.95

CREE® MC-E Ultra High Power LED & Reflector

Much brighter than XP-G CREE® LEDs. Perfect for seriously bright DIY torches or for super efficient lighting in limited power applications.

- Viewing angle w/o reflector: 110°
- Over 430 lumens @ 350mA
- Over 700 lumens @ 700mA.

CREE® MC-E LEDs

- Dimensions: 20(Dia)mm

White ZD-0449

$34.95

Collimator Lens to suit

- Dimensions: 34(Dia) x 16(H)mm

10° Narrow Angle

HP-1280

$9.95

USB DIGITAL TV TUNER

Watch high definition digital telly on your desktop or laptop. Simple to set up and use, just connect the USB stick, plug in the antenna, install the software & away you go. See website for full systems requirements.

$49.00 SAVE $20.00

- Supports free-to-air DTV in many countries
- 1GB Free HD Space
- Software with time shifting & scheduled recording
- Compatible with Windows XP, ME and Vista
- Antenna, cable and software included
- Supports Electronic Program Guide (EPG), subtitle and Teletext

XC-4886 WAS $69.00

All Savings are based on Original RRP

To order call **1800 022 888** **www.jaycar.com.au**

Prices valid from 24/07/2011 to 23/08/2011. Limited stock on sale items. No rainchecks.

Jaycar Electronics

Contents

SILICON CHIP

Vol.24, No.8; August 2011 www.siliconchip.com.au

Features

14 Asus EeePad "Transformer" Tablet PC
It looks and works pretty much like a standard tablet computer but plug in the keyboard and it transforms into a powerful little netbook. We recently got our hands on one to find out what all the excitement was about – by Ross Tester

32 Safely Removing Solder Fumes & Other Pollutants
Solder fumes can be a real problem but not with Hakko's FA-430 fume extractor. It really is a clever not-so-little sucker! – by Ross Tester

86 Review: UP! Portable 3D Printer
Want to make plastic prototypes or scale models at home or in the office? Here's a 3D printer that's affordable for most businesses – by Nicholas Vinen

Projects To Build

21 An Electronic Stethoscope
Want to make sure your heart is still beating? Or sort out unusual rattles in your car's engine? This electronic stethoscope has switchable frequency bands & you can listen via headphones or a loudspeaker – by John Clarke

34 Build A Digital Spirit Level
This project is really on the level. It's the electronic version of the traditional spirit level & can measure the angle of any flat surface from 0-360° in 0.1° increments. It's rugged & easy to build too – by Andrew Levido

62 Ultra-LD Mk.3 200W Amplifier Module, Pt.2
The Ultra-LD Mk.3 is by far our lowest distortion Class-AB amplifier design. Here's how to build it and some more performance data – by Nicholas Vinen

76 Rudder Position Indicator For Power Boats, Pt.2
Second article has detailed instructions for building and testing both the sensor and display units. We also describe how it's installed in a large power boat – by Nicholas Vinen

Special Columns

44 Serviceman's Log
Who pays when it dies on the bench? – by the Serviceman

57 Circuit Notebook
(1) Maximite Stepper Motor Interface (2) Solar Tracking With a Standard Motor Speed Controller; (3) Audio Impedance Meter Operates At 1kHz; (4) Stereo Headphone Adaptor For LCD & Plasma TVs; (5) Shunt Regulator For Lead-Acid Battery Float Charging

92 Vintage Radio
Hotpoint Bandmaster J35DE console radio, Pt.2 – by Maurie Findlay

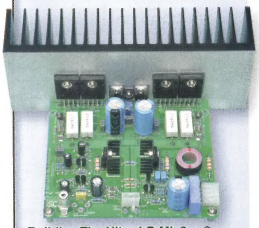
Departments

2 Publisher's Letter
4 Mailbag
91 Product Showcase
98 Ask Silicon Chip
101 Notes & Errata
102 Order Form
103 Market Centre

Asus EeePad "Transformer" Tablet PC – Page 14.

An Electronic Stethoscope – Page 21.

Digital Spirit Level – Page 34.



Building The Ultra-LD Mk.3 Amplifier Module – Page 62.

SILICON CHIP
www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Stan Swan

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490. All material is copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $97.50 per year in Australia. For overseas rates, see the order form in this issue.

Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

E-mail: silicon@siliconchip.com.au

ISSN 1030-2662
Recommended and maximum price only.

Publisher's Letter

Big challenges lie ahead for Australia

As I sit down to write this Publisher's Letter, Australia, the United States of America and Europe are facing dire challenges which will affect their peoples' welfare far into the future.

In the USA, the NASA space shuttle Atlantis has just been launched on its final mission, ending a 30-year program which has sent 135 missions into space. What comes next? The answer appears to be "not very much!" The USA is a very different nation to when the US race to the Moon was launched some 50 years ago by President John F. Kennedy. Those were heady times and the USA was booming, confident and up to the challenge of beating the USSR in the cold war and in the race to the Moon. And we all know that it won both races, convincingly. The US space program was the stimulus for the vast amount of innovation in electronics and all other areas of technology. All the world has benefited, in countless ways.

But today the USA is sick. It could not afford the space race as it did in 1961 and it can't afford to maintain its shuttle program. It is now reduced to using rockets from Russia to continue its manned space activities. Its federal government debt is $14 trillion dollars, equal to its annual GDP. Many states in the USA are virtually bankrupt with California, that once gleaming edifice of technical innovation, now mired in debt, strangled with regulation and weighed down with high unemployment and the aftermath of the financial turmoil which started in 2007. The USA is still has the largest economy in the world but it is in very serious trouble. Can this dire situation be turned around and will the USA boom once again? Perhaps.

As for Europe, once the cultural and intellectual engine of the western world, well it is an economic basket-case. Except for a few countries such as Germany and the Netherlands, it is weighed down with incredible amounts of debt, high unemployment and stifled with regulation by the EU. It is doubtful whether its problems can ever be solved, unless, perhaps, the various countries decide to split from the EU and take back control of their own destinies.

And then there is Australia; beautiful, bountiful Australia. We truly are the "lucky country" (somewhat ironic, since Donald Horne coined that phrase intending an entirely different meaning). But we have been fortunate. Our economy is booming and literally racing along, growing strongly for the last 20 years. Australia's terms of trade are the best they've ever been and our GDP/capita is at the top of the G20 countries.

In fact, except for about half a dozen small rich countries such as Qatar, Luxembourg, Switzerland and Denmark, Australia is the richest large country in terms of GDP/capita, ahead of former leaders such as USA, Canada and Sweden, and way ahead of France, Germany and the UK. To put it in simple terms, the standard of living enjoyed by the average Australian is well above that in America. Unbelievable, isn't it?

Sure, Australia is doing well because of its coal and mineral exports but it has also been doing well in so many other areas over the last two decades. On the other hand, over the last decade or so, both state and federal governments have seemingly been acting to bring it all undone. And just coincidentally, at the same time as the last US shuttle mission is on its way to the International Space Station, Australia is about to launch a so-called "carbon" tax. For the moment, as I write this editorial, the details are unknown apart from leaks over the previous few days about who might be compensated and will be able to carry on doing what they always did, with not too much incentive to change

continued on page 99

GET CONNECTED.

Features

- Search over 2 million products
- Create parts lists and shopping carts
- Place your order
- Access your My Digi-Key account
- Get part specifications and view product photos
- Check out the latest additions to our inventory

Digi-Key® CORPORATION

560,000+ products from 470+ suppliers in-stock and available for immediate shipment.

The industry's broadest product selection available for immediate delivery

www.digikey.com.au/smartphone
www.digikey.co.nz/smartphone

Digi-Key is an authorized distributor for all supplier partners. New products added daily.
© 2011 Digi-Key Corporation, 701 Brooks Ave. South, Thief River Falls, MN 56701, USA

MAILBAG

Letters and emails should contain complete name, address and daytime phone number. Letters to the Editor are submitted on the condition that Silicon Chip Publications Pty Ltd may edit and has the right to reproduce in electronic form and communicate these letters. This also applies to submissions to "Ask SILICON CHIP" and "Circuit Notebook".

Washing machine EMI is unacceptable

Further to the DVD/CD player that radiated EMI (Mailbag June 2011), we just replaced our washing machine with a new one from the same popular NZ manufacturer. The old one was 11 years old and generated some EMI.

The new one is appreciably worse, generating continuous and varying mains-borne EMI that interferes with all AM radios in the house. I have connected a Belkin line filter at the wall socket plus a large DSE ferrite clamp-on filter where the mains lead exits the washer. The noise is maybe 10% less, if that.

This does not seem acceptable – one does wonder about the testing standards. Others must have experienced this and perhaps tried other solutions; maybe some of the many trans-Tasman readers?

Rick Arden,
Gowanbrae, Vic.

Caution required with flood-affected radio gear

I enjoyed reading the article on rescuing electronic gear after a flood (SILICON CHIP, June 2011). One thing did concern me though.

In the article he mentions a white powder which he believed was corrosion from a solder alloy. However, military radios often use beryllium copper in washers. While relatively safe in its normal form, it can be quite hazardous once it begins to corrode, when it becomes a white powder.

Benjamin Gillies,
Bendigo, Vic.

Comment: although beryllium may be suspected if there is a white powder, parts made from zinc or aluminium can also turn to a white powder when they corrode.

Clarification on flash drives

On page 100 of your April 2011 edition, in response to a question on storage size, you wrote of FLASH memory: "if you refer to **http://en.wikipedia.org/wiki/Flash_memory** you will find the origin of the word flash is not an acronym but is descriptive of the erase mode. It's also not a proper noun. Therefore "flash" should be lowercase: making it upper-case misleadingly suggests that it is an acronym".

Though I agree with your summary that hard disk size nomenclature can be a product of sharp marketing, I thought that, owing to the chip nature of flash, it was unlikely that flash memory would be other than a multiple of a power of two in size of unformatted capacity.

When looking at the available capacity of a drive, whether mechanical or solid state, the user sees the formatted capacity. The drive is partitioned and each partition is formatted using FAT32 , NTFS, ext4 or other layout that the operating system can use.

Formatting significantly reduces the user space on a drive because of the space allocated to boot records and look-up tables and indices of the physical location of user files.

New formats such as ext4 also have journaling files to improve data integrity. Thus the available space in a flash drive will be a few percent less than the power of two, depending on the formatting used and the size of the internal data.

Kevin Shackleton,
Cottesloe, WA.

Comment: flash (not FLASH) memory chips would almost certainly be fabricated in a power-of-two size. However some portion of the flash memory is usually set aside to replace blocks which go bad with use and that is subtracted from what is available initially.

The proportion of the capacity lost to formatting is usually fairly small, something like 0.1% or less, so we don't think that's the explanation. As an exercise, consider the proportion of a 4GB memory card formatted with FAT32/16k blocks that's consumed by the file system itself. You have two file allocation tables with 4GB/16k = 262,144 32-byte entries each for a total of 2MB. Then you have the directory

HAKKO

Hakko FX888
General purpose soldering iron
- Compact
- Lead or lead-free solder
- Excellent thermal recovery
- With tip conical shape T18-B, cleaning sponge and wire

Hakko FX951
Advanced lead-free soldering iron
- Heating element and tip in one
- With sleep mode, auto shutdown, lock out card, quick tip replacement.

Hakko FR803B
Hot Air SMD Rework Station
- Digital station with 3 steps temp profiles
- Vacuum pickup
- Adjustable 100°-450°C
- Optional stand, pre heater and vice

Proudly distributed in Australia by
HK Wentworth Pty Ltd
www.hakko.com
Hakko Specials this month: see your Hakko distributor!

structure which is a few KB with a modest number of files.

It's certainly less than 4MB which would be around 0.1% of the total capacity.

If hard drives were consistently sold based on 1k = 1024 bytes then flash manufacturers would need to fabricate extra memory for bad block reallocation. They could do that but it's easier to just round the capacity down to units of 1000 and then use what's left over as the spare blocks, which makes it cheaper to fabricate.

Flash drives can have a short life

I would like to know if other readers have experienced flash drives that fail and their opinions as to why they might have failed. I have just had a third 8GB flash drive fail and even though I back up the drives, I always lose a small amount of data at the failure, which is inconvenient.

I use my flash drive to carry data from one computer to another. Once the data has been copied, I erase the files and reuse the space. It seems that I can only fill and erase the drive about eight times before it fails.

I have asked the manufacturers for information as to why my F/Ds have failed but I have not received any replies. The F/D is replaced under warranty but the unreliability is a worry. Am I unlucky or is the technology unable to withstand repeated deletes and writes?

I recently read a computer conversion review, in which the conventional hard disk was replaced with a solid state drive (SSD). The reviewer stated that constant writing can shorten the life of the SSD, even though the manufacturers claim a Mean Time Before Failure of 57 years. Does this limitation also apply to F/Ds?

Anthony Farrell,
Chinderah, NSW.

Comment: eight rewrites seems very poor. Flash memory certainly withstands a limited number of rewrite cycles but with good quality flash, you usually get at least 1000 rewrites.

Alternatives to costly hearing aids

Further to Clive Singleton's letter concerning costly hearing aids in the Mailbag pages of the June 2011 edition, I have bought two digital hearing aids, for $3200, supposedly with noise-reduction technology. Even though they work quite well in a quiet environment, if there is background noise or more than one conversation being carried out at one time, they are practically useless.

I also have Digitor MegaEars, bought from Dick Smith that cost about $13.00, which I use in my workshop at smoko time. This may not look quite as pretty but considering the price difference, they have a lot going for them.

A friend of my mine has referred me to **alibaba.com** where Siemens hearing aids are available for $100. He insists that he has bought a lot of goods from there and has always been happy with service and quality.

Another thought: surely Bluetooth technology could be adapted to hearing aids, using the mobile phone as an amplifier-transmitter and with a properly fitted Bluetooth receiver in the ears.

Harold Cislowski, VK4ANR,
Ayr, Qld.

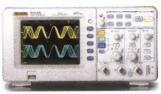
There are two common types of flash memory, SLC (single level cell) and MLC (multi-level cell). Each flash unit is essentially a Mosfet with a well-insulated gate capacitor. The gate can hold its charge for many years.

A (relatively) high voltage is used to erase the data (reset the capacitor) as this allows electrons to tunnel through the insulation (ie, essentially it suffers breakdown) and charge the capacitor.

For high-density/low-cost flash, as is commonly used in USB drives and SD cards etc, MLC flash is used. Multiple bits are stored in each gate (usually two) by the use of several voltage thresholds. For example to store four bits in one gate, the thresholds might

Australia's Best Priced DSOs

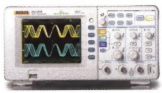
Shop On-Line at emona.com.au



RIGOL DS-1052E 50MHz

- 50MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- USB Device, USB Host & PictBridge

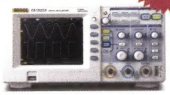
ONLY $439 inc GST



RIGOL DS-1102E 100MHz

- 100MHz Bandwidth, 2 Ch
- 1GS/s Real Time Sampling
- USB Device, USB Host & PictBridge

ONLY $769 inc GST



RIGOL DS-1202CA 200MHz

- 200MHz Bandwidth, 2 Ch
- 2GS/s Real Time Sampling
- USB Device & USB Host

ONLY $1,422 inc GST

Sydney Tel 02 9519 3933 Fax 02 9550 1378
Melbourne Tel 03 9889 0427 Fax 03 9889 0715
email testinst@emona.com.au

Brisbane Tel 07 3275 2183 Fax 07 3275 2196
Adelaide Tel 08 8363 5733 Fax 08 8363 5799

Perth Tel 08 9361 4200 Fax 08 9361 4300
web www.emona.com.au

EMONA

Custom Front Panels & Enclosures

Sample price $57.32 + S&H

Designed by you using our FREE software, Front Panel Designer

- Cost effective prototypes and production runs
- Powder-coated finish and panel thickness up to 10mm now available
- Choose from aluminum, acrylic or customer provided material
- 1, 3 and 5-day lead times available

FRONT PANEL EXPRESS

FrontPanelExpress.com
+1 (206) 768-0602

DYNE INDUSTRIES PTY LTD

Now manufacturing the original ILP Unirange Toroidal Transformer

- In stock from 15VA to 1000VA
- Virtually anything made to order!
- Transformers and Chokes with Ferrite, Powdered Iron GOSS and Metglas cores
- Current & Potential Transformers

DYNE Industries Pty Ltd
Ph: (03) 9720 7233 Fax: (03) 9720 7551
email: sales@dyne.com.au
web: www.dyne.com.au

Mailbag: continued

Variable speed drive could cause motor bearing damage

Thank you for the interesting article about the FutureWave Energy Saver in the June 2011 issue. Many model engineers drool over the prospect of owning a variable-frequency drive to control the spindle speed of their lathes and mills without the need to constantly change belts. Several ready-made products are on the market but they tend to be rather expensive.

In following up the literature about these devices I encountered strong recommendations for a filter between the VSD and the motor in order to keep the high-frequency components of the switching out of the windings. The reason is that the small capacitance between the stationary windings and the spinning rotor actually couples significant current to the rotor and this current exits via the ball bearings, severely shortening their operational life!

Remember that circular surfaces only make contact over quite tiny areas and with lubricants getting in the way there is quite some prospect for minute sparking. Apparently the initially shiny balls can end up looking as if they had been sand-blasted after quite a short period of time.

Graham Lill,
Lindisfarne, Tas.

Comment: we actually tried using a line filter with the FutureWave device, to try and clean up the waveforms for measurement on the scope. However, it refused to operate with an external filter in place.

It is surprising that the relatively small capacitance involved could carry enough current to damage ball bearings but we accept that it could possibly happen. We measured around 3nF from Active to frame on a typical pool pump motor and considering the high voltage and high switching frequencies involved, that may well explain it.

be (say) 0.5V, 1.0V and 1.5V. For SLC flash, each gate is either charged or discharged so there is only one threshold.

The high-voltage erase cycle slowly erodes the insulating layer and eventually one or more bits can no longer reliably hold their charge. This happens sooner with cheap MLC flash because the voltage thresholds are closer together. MLC flash is also slower to read/write. High-end solid state disks use SLC because of its better performance and reliability but they also cost a lot more.

Errors are common enough with MLC flash that the chips incorporate some fairly heavy error checking and correction logic. If this is not sufficiently robust or the flash cells are unusually unreliable, the flash memory will fail after just a few rewrite cycles. It sounds like this is what you are experiencing and it could be due to either poor design or an unusually bad batch of memory chips.

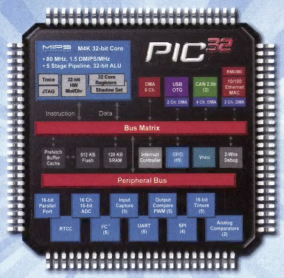
Also, virtually all flash memory chips contain some unallocated space that is used to replace portions of the chip that go bad over time. This helps extend the life in case there is a defect in a particular place on the chip that makes that location fail early. Flash drives also usually include "wear levelling" logic. This ensures that even if you rewrite a file many times, it is written to different blocks within the flash so that a single block doesn't wear out prematurely. Better flash drives have more advanced logic which may do a better job of distributing the writes, to give the flash a longer life.

Note that even the high-end SLC flash-based solid state drives have a finite rewrite life. In some cases (eg, Intel SSDs) they will actually slow down their write performance if they are being heavily rewritten, to prolong their life.

Achieving zero null on the low capacitance adaptor for DMMs

I have built the Low Capacitance Adaptor (SILICON CHIP, March 2010) from a kit. However, when I attempted to adjust the zero null trimming capacitor, I found that I could not adjust the output correctly to 0mV. The best null obtained was about 20mV.

Accelerate The Performance Of Your Design With the PIC32 Microcontroller



PIC32®

PIC® MCU to the power of 32

Are your growing applications demanding more performance? PIC32 does more with less!

With market-leading performance of 1.56 DMIPS per Megahertz from the MIPS® M4K® Core, Microchip's PIC32 is the right choice when you need to get more done with fewer clock cycles.

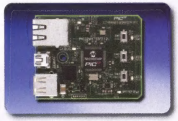
While performance is important, we know that getting your design to market quickly, with the right feature set is what really counts. Microchip's proven peripheral libraries and MPLAB® Integrated Development Environment offer compatibility across 8-, 16- and 32-bit PIC® microcontroller families making migration easy and your time to market its shortest.

Find out more at www.microchip.com/pic32 or check out what's happening in the community at www.mypic32.com

GET STARTED IN 3 EASY STEPS

1. Purchase a PIC32 Ethernet Starter Kit
2. Download MPLAB® IDE
3. Order samples and start designing!

www.microchip.com/graphics



PIC32 Ethernet Starter Kit (DM320004)

Microchip Technology Australia
Tel: (02) 9868 6733 E-mail: aust_nz.inquiry@microchip.com

microchip DIRECT
www.microchipdirect.com

www.microchip.com/pic32

MICROCHIP

The Microchip name and logo, the Microchip logo, PIC and MPLAB are registered trademarks of Microchip Technology Incorporated in the USA and other countries. All other trademarks mentioned herein are property of their respective companies.
© 2011 Microchip Technology Incorporated. All rights reserved.

Specialist loudspeaker drivers from:
GERMANY
VISATON®

With over 40 years of experience in acoustics and speaker technology, Visaton are a market leader. They offer a huge range for almost any speaker project. Comprehensive data is available online. Ph. (02) 4627-8766 or (03) 9859-0388
- Drivers up to 15"
- Fullrange & wideband
- Miniature & shielded
- Horns & coaxial drivers
- Hifi - DIY - Projects
- Communications
- Public Address
- Manufacturing
soundlabs group
www.soundlabsgroup.com.au

Mailbag: continued

By removing the zero null variable capacitor, the output to the DMM was reduced to 12.5mV, indicating that the stray capacitance of the terminal posts was 1.25pF. This was less than the 3pF minimum capacitance of the null capacitor.

The solution was to add a 4.7pF NPO ceramic capacitor in parallel across the PCB terminal pins to the terminal posts which brought the stray capacitance up to a level within the range of the null trim capacitor and the balance was then perfect at 0mV.

Tests showed that the adaptor now reads correctly with very small capacitors connected to it. I issue this advice to any one who may experience the same problem.

Arthur Forster,
Blaxland, NSW.

Earthing of vintage radios

In the "Vintage Radio" column in the March 2011 issue I note that Rodney Champness makes a comment about not being able to fit a Nylon cable gland into the STC clock/radio chassis to anchor the mains lead. Now I totally agree that tying a knot in the lead is not compliant and is unsafe as well.

I can't see why a clamp couldn't be made out of a small strip of steel with a piece of PVC or heatshrink sleeving slid over it (so that the sharp edge won't cut into the sheath of the mains lead) and bolted onto the chassis using two screws and nuts. Alternatively, a piece of steel could be formed into a ring (once again sleeved), wrapped around the mains lead and bolted onto the chassis using just one screw or nut.

Of course, the power lead would need to be protected as it goes through the chassis by a suitable grommet but that grommet wouldn't protrude as far into (or out of) the set as a gland does. I can't find anything in the Electrical Codes of Practice that prohibit doing it this way.

Rodney also mentioned that the electric clock movement that was fitted to that radio had a stripped gear. Someone in the horological (time and clock) industry would most probably be able to help him with repairs to this clock.

I "Googled" a company here in New Zealand a couple of years ago regarding fixing an old Smiths electric clock and I got a positive reply from the person concerned to the point that he almost guaranteed that he would be able to effect a repair on the clock for me. As it happened, I didn't follow through with the repair at the time, but it does give hope that these old electric clock movements can be saved.

Peter Walsham,
Auckland, NZ.

Charging iPods from standard USB ports

In response to the question from E. J., Otago, Tasmania (Ask Silicon Chip, July 2011, page 98), the resistors required in order to allow an Apple iPod device to charge from standard USB sockets are described in the schematic for the Adafruit Industries "MintyBoost" kit. This can be found at: **www.ladyada.net/images/mintyboost/mintyboostv3sch.png**

Note the resistor values used to divide the +5V for USB D- and D+. The resistors can be easily sourced from Element 14.

John Boxall,
Stanford Merthyr, NSW.

An extended memory card unit for the DAB+ tuner

The DAB+/FM Tuner in the October and November 2010 issues interested me as I have a Pioneer AM/FM radio with a 2-stack plus one external slot CD player. This unit would be a modern upgrade except it falls short in the amount of storage in the memory card.

It started me thinking of ways to provide more memory capacity and I believe this will become more important in the future. Adding a module housing nine additional memory cards would be the way to go. A single digit display, 0-9, would indicate the card in use which would be electronically switched, activated by two buttons; one up and one down.

This potentially gives a memory capacity of 32GB x 10 = 320GB which would hold a lot of music or data. This would become more viable as memory prices drop. I think that this would be a common module for many projects in the future which require data storage. Projects

using data storage only would use 10 internal cards.

My CD player indicates 0 for the external slot, which is handy for playing new CDs or checking newly burned CDs before loading them internally, and 1 - 25 for the internal stack. Ideally, a moulded housing with a lid could house 10 memory cards. The housing would need to accommodate 10 memory cards for data but only nine plus one external card for music.

In the DAB+/FM radio, the presence of a card is detected at switch on. This would need to be changed to detect when switched.

Alan Dennis,
Christie Downs, SA.

An insight into variable speed drives

Further to your article on the FutureWave Energy Saver in the June 2011 issue, a few comments on variable speed drives (VSDs) might be of interest to your readers.

AC VSDs rectify the mains power to DC, then reconstitute it to variable frequency AC to achieve speed control over the motor. Most VSDs, particularly small ones, use diodes to rectify the incoming mains voltage. Current can only flow through the diodes when the sinusoidal mains voltage has risen to a value that exceeds the DC bus voltage.

As a consequence, the current drawn from the mains is not a corresponding smooth sinusoid and generates harmonics in the mains that are one source of interference.

As an aside, there are some VSDs that use a switchmode "active front end". These use a boost configuration and can draw current from the mains throughout virtually the entire 50Hz sinewave.

Not only does this reduce the harmonics content but the power factor can be controlled to be unity or even leading, and the front end and DC bus can operate as a stand-alone power factor correction unit. These units can

How to check infrared remote controls

I must thank the Serviceman for his June 2011 column. I have just bought a very expensive IR repeater system (RESI-LINX) so that I could operate my TV-related AV system behind a cupboard door. It works extremely well except, frustratingly, the power toggle signal to the Foxtel box didn't work.

Every other function on the Foxtel, Blu-ray player and AV receiver units worked perfectly. The repeater instructions were a bit vague about emitter placement, so I just stuck them directly over the remote sensor.

I was beginning to think I had wasted $200 when I read your column and you mentioned that you could see IR signals by using a digital camera. Genius! It was a simple matter to verify where the IR signal was actually emitted and this made the emitter placement easy. The system is now 100% reliable.

Marc Hillman,
Donvale, Vic.

OCEAN CONTROLS
Helping to put you in Control
Control Equipment

Power Meter Fitted with a 0-50A current transformer this panel meter displays AC Volts (0-300V), AC current , Frequency(Hz) and Power (Watts). Fitted with RS485 Modbus connection for SCADA monitoring
AXI-040 $199.00+GST

4-20mA Signal Isolators Avoid ground loops by providing single and dual loop galvanic isolation. Power is drawn from the 4-20 mA input loop. **From SIG-201 $129+GST**

Solar Temperature Controller Contol your solar water heating. Comes with 2 NTC thermistor sensors.
CET-033 $79.00+GST

Freetronics Eleven Based on the Arduino Uno it has extra features like a prototying area, LED's to help debugging, mini USB connector, ATmega328P CPU and it's 100% Arduino compatible.
FRA-003 $36.32+GST

IOIO for Android Uses USB to connect to an Android device. The IOIO is fully controllable from an Android application, using a Java API
SFC-070 $49+GST

PID Process Controller Fitted with a universal analog input, 4 relays, 4-20mA and pulse outputs and a 96 x 96mm display. Powered via 240VAC or 24VDC.
PID-030 $269.00+ST

Dual Stainless Steel Float Switches Can be used to control pumps emptying or filling a tank
HES-113 $27.95+GST

Contact Ocean Controls
Ph: 03 9782 5882
www.oceancontrols.com.au

Mailbag: continued

Vale Bob Barnes

Bob Barnes, of RCS Radio Pty Ltd, died during June 2011 after a short illness. Many readers would have had dealings with Bob over the years as RCS Radio was the supplier for a vast range of PCBs for projects published in SILICON CHIP, Electronics Australia, ETI and AEM magazines.

Bob was a very colourful character who could be kind and very helpful to his many customers but somewhat abrasive to others. He was an encyclopaedic source of information on PCBs, their design and manufacture and had many industrial customers as well as the regulars who purchased boards for magazine projects. Without his ongoing support, thousands of electronics enthusiasts would been unable to build a lot of the more unusual projects for which kits were unavailable.

Bob was a Vietnam veteran and had many years service in Army Intelligence which gave him a unique insight into the use and workings of electronics in armament systems. Part of his expertise in PCBs came from his period spent at the Boeing plant in the design of mil-spec PCBs for avionics. That led to his obsession and insistence on high standards for PCB design.

He will be sadly missed. Bob's son Andrew will carry on the RCS Radio business and further information can obtained on the website **www.rcsradio.com.au**

also be made to regenerate back into the mains to return energy and help to brake the motor.

The torque output of an induction motor is proportional to its current. The amount of heat produced in the windings is actually proportional to the square of the motor current.

The inductance of a motor at constant torque is more or less constant so, as the frequency of power supplied to it reduces, the motor current would tend to increase proportionately if the motor voltage was held constant.

As increased current would tend to overheat the motor, the apparent voltage of the motor supply therefore needs to reduce in proportion to the reduction in frequency. Thus, at half the motor's rated frequency, the apparent voltage needs to be about half the motor's rated voltage in order to not exceed the motor's rated current.

Mechanical power is the product of torque and speed. As the frequency is reduced below rated, the current and hence the torque is held constant but the speed reduces in proportion to the frequency. Thus, at half rated frequency, the torque is the same but the speed is halved, so the power is halved. Note also that the motor voltage is halved, although the current remains the same, so the electrical input power is halved, which is what you would expect.

Even though the motor is operating at half-speed and at half-power, the current in the windings remains the same, so that the heating effect is the same as at full power. The volume of air produced by the shaft fan is roughly proportional to the square of the shaft speed so that, when it is running at half its rated speed, its cooling effect is really only about a quarter of that at rated speed and so overheating can be a problem.

As a result, for large motors intended for variable speed operation, motor manufacturers will often supply a separate fan motor intended to run constantly at mains frequency.

As another aside, it is equally possible to operate the motor at above its rated frequency. What happens then though is that, at (what is now constant) rated voltage, the effect of the motor-winding inductance reduces the motor current as the frequency is increased.

You therefore have the situation where the motor voltage remains the same, while the current and hence the

torque reduces as the speed increases.

This tends to hold the motor power approximately constant. Unfortunately though, the power demanded by most mechanical loads increases in proportion to the shaft speed or in the case of pumps and fans, in proportion to the square of the speed. So a motor run above its rated frequency soon runs out of power to drive its load, assuming that they were reasonably well matched in the first place. There are also mechanical limits on how much above rated speed a motor can be operated.

The "reconstituted" AC supplied to the motor is actually a series of full voltage pulses supplied from the DC bus. To minimise heating of the power electronics, the rate at which they switch from off to on and back again needs to be very fast, so the pulses are almost square. When these pulses arrive at the motor windings, they increase in magnitude and cause considerable voltage stress to the first few turns. This means that large motors intended for VSD operation require upgraded insulation to cope with this voltage stress over the life of the motor.

The pulses are also a source of radiated interference and high-power VSD installations tend to use over-all shielded and specially balanced cables to minimise radiation. It is possible to fit filters to minimise radiated interference but these tend to degrade the performance of the VSD, as indeed do excessively long motor cables.

Three-phase motors can be started by a VSD by ramping the frequency up from a low value, (or even DC), while adjusting the apparent voltage to keep the motor current at rated. These motors can therefore start and run up at full torque but without the bump involving five to eight times the rated current that occurs when a motor is started direct on-line at rated voltage and frequency.

As single-phase motors, such as pool pump motors, ordinarily rely on a separate start winding fed via a capacitor, low-frequency starting cannot be used. These must therefore be started at or near rated frequency and the only option available to "soften" the start is to ramp up the voltage.

The above comments are actually a great simplification of a very complex topic but they do provide some useful rules of thumb. They are not intended as any criticism of the FutureWave device, which no doubt does what it claims, however an appreciation of the broader picture might be helpful.

Don Brown,
Beachmere, Qld.

SILICON CHIP collection available

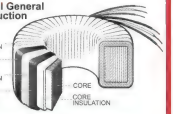
Bearing in mind those readers who may have lost their collections of SILICON CHIP in recent natural disasters, I have copies of the magazine dating back to the early days that I am happy to give away to a good home. I can be contacted at my email address: **wvbartholomeusz@aol.com**

Thanks to all at SILICON CHIP for a great magazine that I look forward to each month.

Wil Bartholomeusz,
Sydney, NSW. SC

ANTRIM TRANSFORMERS
manufactured in Australia by
Harbuch Electronics Pty Ltd
harbuch@optusnet.com.au

Toroidal – Conventional Transformers
Power – Audio – Valve – 'Specials'
Medical – Isolated – Stepup/down
Encased Power Supplies



Comprehensive data available:
www.harbuch.com.au
Harbuch Electronics Pty Ltd
9/40 Leighton Pl, HORNSBY 2077
Ph (02) 9476 5854 Fax (02) 9476 3231

ATTEN® INSTRUMENTS **Digital Storage Oscilloscopes**

ADS1022C	25MHz Bandwidth, 2Ch 500MSa/s USB Host & PictBridge	$399 Inc GST
25MHz		
ADS1062CA	60MHz Bandwidth, 2Ch 1GSa/s USB Host & PictBridge	$627 Inc GST
60MHz		
ADS1102CA	100MHz Bandwidth, 2Ch 1GSa/s USB Host & PictBridge	$836 Inc GST
100MHz		

WILTRONICS
36 Years Quality Service

For full spec sheets and to buy now online, visit
www.wiltronics.com.au
Ph: (03) 5334 2513 Email: sales@wiltronics.com.au

Dick Smith - Your Comple

CLEARANCE

$49.98

SAVE $20

PRO-70K Butane Solderpro Kit

Cordless 70W butane soldering iron kit; soldering tip plus hot knife, 'heat blower' and blowtorch tips, solder, cleaning sponge, handy carry case. Clearance line, limited store stock only. Not available for Web or mail orders. T1105

$59

SAVE $40

Dick Smith Temperature Controlled Soldering Station

Quality soldering station, slim 48W soldering pencil, 1.6mm long-life tip, cleaning sponge. Adjustable 150°C - 450°C temperature with front panel metering. Not carried in all stores, but can be ordered in. T2200

$6.99

SAVE $8

Dick Smith Anti-Static Solder Sucker

Easy-to-clean solder sucker with a strong metal body, excellent suction and a heat-resistant Teflon tip. Not carried in all stores, but can be ordered in. T2567

$12.99

SAVE $7

Dick Smith 60W Soldering Iron

Provides extra heat reserves for those larger jobs. With 240V operation, 470°C operating temperature, long-life plated tip, lightweight handle and a mini soldering iron stand. Not carried in all stores, but can be ordered in. T2309

CLEARANCE

$19.99

SAVE $20

IRODA PT-200 Butane Powered Blowtorch

Powerful, heavy-duty butane blowtorch with adjustable flame for hobby users. Electronic ignition, with temperatures up to 1300°C, and up to 60mins use per refill. Internal brass and ceramic parts for precision operation. Colour may vary. Clearance line, limited store stocks only. T1101

$1.99

Dick Smith 6-Piece Jeweller's Screwdriver Set

Phillips and flat-head screwdrivers with free-running tops, supplied in a plastic storage box. T4360

$6.97

SAVE $3

Dick Smith 6-Piece Screwdriver Set

Contains 1 x #2x100mm Phillips, 1 x #1x75mm Phillips, 1 x #0x75mm Phillips, 1 x #3.2x75mm Flat head, 1 x #5x75mm Flat head, and 1 x #6x100mm Flat head. Strong chrome vanadium steel tips. Not carried in all stores. T6321

$7.99

SAVE $5

350pc Cable Tie Pack

Pack contains 100pcs each of natural and coloured 100mm x 2.5mm, 50pcs each natural and coloured 200mm x 2.5mm, and 50pc coloured 280mm x 3.5mm cable ties. H5964

$39.90

SAVE $10

Dick Smith Pocket Digital pH Meter

A pocket-sized pH meter with Auto Temp Compensation and a simple calibration process. Measures pH values from 0 to 14 with +/- 0.2pH accuracy, as well as temperature readings. Not carried in all stores but can be ordered in. Q1391

Looking for your nearest Dick Smith store?

Head to dicksmith.com.au!

te Technology Destination

$69

SAVE $30

Dick Smith Digital Sound Level Meter
A quality digital sound level meter with auto and manual ranging plus a fast digital bargraph. Provides metering of 40dB to 130dB SPL with A and C weighting. Includes fast and slow metering response, Min/Max recording, and Auto Power Off function. Great for checking sound levels in factories, schools and offices. Not carried in all stores, but can be ordered in. QI3662

$49.86

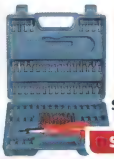
SAVE $30

digitor
Automotive Multimeter
Multimeter and automotive tester in one. Measure RPM, DWELL angle, current, temperature and more. Includes inductive pick-up, temperature probe, rubber holster and test leads. Not carried in all stores, but can be ordered in. QI3585

$19.99

SAVE $10

Dick Smith Personal Visor Magnifier
Selectable 1.8x, 2.3x and 4.8x magnification, adjustable headband and integral illuminating lights (batteries required, not supplied). Not carried in all stores, but can be ordered in. T4598



$19.99

SAVE $10

Dick Smith 101pc Bit Set with Carry Case
Ideal for the home maintenance or electronics enthusiast. An enormous collection of screwdriver bits, including Torx, Pozidriv, Tri-wing style security bits and a driver handle, all stored in a rugged carry case. T4513

$19.99

SAVE $10

Dick Smith 6/8 Pin Modular Crimping Tool
Cuts and strips cables as well as crimping various 6 pin and 8 pin modular connectors including 6P4C (RJ-11), 6P6C (RJ-12), and 8P (RJ-45) varieties. Rugged metal construction for accurate crimps. Not carried in all stores but can be ordered in. T2920

$6.99

SAVE $9

Dick Smith Gas Jet Spray Can
Helps remove dust and lint from external surfaces of most electrical and electronic equipment. Flammable, use in well-ventilated areas. 250g can. Not carried in all stores, but can be ordered in. Not available by mail or web order. N1123

$12.99

SAVE $7

Dick Smith 30pc Hardened Mini Bit Set
Made from super-hard S2 grade steel, ideal for use in speaker, TV and AV installations. Includes handle, storage case and extension shaft. Not carried in all stores, but can be ordered in. T6537

$14.99

SAVE $10

Eneloop USB Charger with 2 x AA NiMH Batteries
Simply plugs into the USB port of your laptop or PC, charges AA or AAA Eneloop batteries. Includes 2 x Eneloop 2000mAh AA batteries. S4466

$29.97

SAVE $10

Dick Smith 389pc Crimp Terminal Kit
High quality crimp-style terminals stored in a handy plastic case with 18 compartments. Includes ring, bullet, tab and butt-style terminals. H5063

Offers start 25/07/11 and ends 31/08/11 or while stocks last. All offers are for retail store stock only, with strictly limited stock available. Some items may not be available for mail orders, stock movements between stores and back orders. No rainchecks. No layby. Enthusiast electronic items are not available in all stores. Offers may not be available in some reseller or franchise stores. Please contact your local store to determine availability.

dick smith
Talk to the Techxperts

Is this th

With the exception of the Apple iPad, few new computers of any description have caused so much comment, so much anticipation and so much demand as the just-released ASUS EeePad Transformer. We just had to get our hands on one for a few days – not easy! – to find out what the excitement was/is all about.

Asus EeePad "Transformer" Tablet PC

Review by Ross Tester

By and large, we've resisted the temptation to jump on the iPad bandwagon.

When it was released, the iPad was described (in the Wall Street Journal, no less) as the "laptop killer". Now we've seen the Asus EeePad Transformer described as "the iPad killer". That might be pretty optimistic given the iPad's huge base.

But if there is one thing the iPad *has* done it's to change the way people think about computers.

Going back a decade or more, computers were those big boxes that sat on or under desks with large monitors occupying valuable real estate. Then along came laptops and (later) notebooks and netbooks which, while maybe not offering quite the performance of the boxes, were more than adequate for the needs of most users.

Gone were the big boxes and large monitors – everything you needed was self-contained. And they were portable – you could take your PC with you and effectively work anywhere.

That's not a reduction – that's an actual size edge-on view of the Asus EeePad Transformer, albeit without the dock/keyboard which would roughly double the thickness. When docked, the whole thing becomes a powerful netbook.

e iPad killer?

Whether that was a positive or not is arguable: just ask those who now spend hours at home working on their notebooks when they might have stayed back at work . . .

Now computers have taken the next quantum leap with the burgeoning "tablet" market – and while the iPad might not have been the first, it was the first which made huge inroads into that market.

But there are quite a few things about the iPad that users and reviewers have questioned – such as why it doesn't handle Flash, the near universal website utility. Or why it doesn't have USB? Or why it is so expensive? Or why Apple has seen fit to try to force users into proprietary Apple applications? Or why Apple are "locking out" content providers unless they are part of Apple's own supply channel (with, of course, large royalties back to Apple)? And so on.

Despite the quite unbelievable success of the iPad and to a lesser extent, several other tablet computers on the market, it has to be acknowledged that a tablet will (in most circumstances) not take the place of a fully-fledged computer (desktop or notebook) simply because it is not designed to do so.

Tablets are convenience devices. They're small, lightweight and for the most part offer good or exceptional graphics capability.

But the one thing they don't have is a "normal" keyboard. And if you ask anyone who has to punch out an email or text document using the "glass keyboard" which they all offer, it is a pain.

It's slow, it makes errors much more likely and because of its inconvenience, it perpetuates that awful practice of "txt splng".

Indeed, one popular after-market accessory purchased for most Tablet PCs is a USB or wireless keyboard! This might limit their portability somewhat but it certainly increases their useability!

Incidentally, the iPad is the obvious exception because, as mentioned above, it doesn't offer USB expansion. Apple apparently want everything kept either "in house" or at least Apple-controlled.

But even without a keyboard, depending on the tablet itself, its installed programs and their capabilities, tablet PCs are fantastic for handling any visual-oriented task, whether that is watching movies, sharing pictures, reading ebooks, using social networking sites such as Facebook and youtube and much, much more.

In fact, most of the major manufacturers believe that this is the direction which all computers are heading; so much so that they are putting most of their eggs firmly into the Tablet basket (eg, Apple!).

Already, tablet sales are increasing very much faster than their deskbound or lap-bound counterparts. Is this just a fad? The manufacturers don't think so!

Enter Android

Originally developed for mobile devices by Android Inc (but now owned by Google), Android is an operating system, just as is Windows (in all its iterations), Apple's iOS and OS X and even Linux/Unix.

In fact, Android is based on the Linux kernel and like Linux (but unlike Windows, iOS etc), is an "open source" system.

After Google purchased Android back in 2005, they released most of the Android code under the Apache licence, which in effect means that anyone can write Android applications or "apps".

World-wide, huge numbers of developers continually churn out new apps for Android – currently approaching a quarter of a million – and the Android Open Source Project is responsible for further development of the system.

You may know Android as the operating system behind your "smart" phone – Samsung, HTC and many other modern phones are now based on it – but in recent times, especially since the release of Android 3.0 and 3.1, it's found its way into a high proportion of tablet PCs, which have recently or are about to hit the market.

It's the familiar Android logo, in this case overlaid with Honeycomb (Android V3.0/3.1), the operating system used in the Asus Transformer.

Earlier this year, Google claimed that 400,000 new Android devices were being activated every day, with more than 100,000,000 devices in use. One quarter of all new phones are said to be Android-based.

Incidentally, you may see references to several Android names, such as Éclair, Froyo, Gingerbread and Honeycomb. The more astute will have noticed that these stand for versions E, F, G and H corresponding to Android 2.0/2.1, 2.2, 2.3 and the latest (more tablet-oriented) 3.0/3.1.

The next version, due for release later this year, will be called Icecream Sandwich and is expected to be a combination of the best features of Gingerbread and Honeycomb, thus blurring the already hazy distinction between Android mobile phones and Android mobile computing.

And thus it is that our attention now turns to a tablet PC which not only features the latest iteration of Android . . . it's also solved the keyboard problem most elegantly, with the function-

ality of a notebook and the portability of a tablet.

The Asus "Transformer"

For reasons that will become obvious in a moment, Asus have named their EeePad TF101 Tablet Computer the "Transformer".

This machine had created a great deal of excitement in the computer world, even before its release to the public in April/May of this year.

We first heard about the Transformer from overseas reports in March when it had its public debut in Taiwan on Friday, March 25th and in the US in April.

While retail stocks were still very much unavailable, it was receiving the proverbial "rave reviews" from those who had been lucky enough to get their hands on one.

Following this, various reports waxed eloquent about the machine and this caused much excitement in chat rooms and forums, with customers clambering over each other to get their hands on one.

First it was a trickle supply and some people were willing to pay way over the odds to be the first. Others lamented the lack of availability in their favourite stores while a few, very few, who had managed to buy one raved about it – which of course further increased demand.

Until late May, when stocks became available in numbers in the US, it was amusing to read the lengths some went to – like ordering at six different stores and cancelling when the first one turned up. In the unlikely event that they got "stuck" with two or three, no problem. Good ol' eBay ensured they would more than get their money back (and then some!).

For all intents and purposes, it looks like a pretty standard Android tablet computer. But there are quite a few surprises under the Gorilla Glass screen!

We've seen the Transformer being auctioned on eBay for more than double its US release price!

The models

The EeePad Transformer is available in two models, apparently identical except for the amount of solid-state disk drive capacity each contains.

The TF101A has a 16GB "disk" while the TF101B doubles that to 32GB. They feature a 10.1-inch WXGA touchscreen, an Nvidia Tegra 2 dual-core processor with 1GB of RAM and both Bluetooth (2.1) and WiFi (b, g & n) built in.

Unfortunately, there is no 3G model but depending on who you believe, Asus plans to bring a 3G model out later this year (or they don't, because someone knows someone in Asus who assures them it's not happening . . .).

The screen on the Asus EeePad Transformer is an IPS panel and it's one of the best tablet screens around – almost on a par with the iPad.

Colours are bright and vivid, contrast is decent and the viewing angle is excellent. When watching videos, the picture is smooth and sharp while the touch input is extremely responsive.

With its Dow-Corning Gorilla Glass coating, it will also handle some pretty rough treatment. One thing I have to say is that it shows fingerprints badly – but a wipe with a damp cloth soon fixes that problem.

There is a mini HDMI output if you want to use the Transformer as a playback device for home theatre or suitable TV sets, a headphone jack and microphone and a MicroSD card slot. There are two cameras built in, the one facing the user has 1.3MP resolution while the outward-facing is 5MP. Video is recorded at 1280 x 720 (HD) resolution but the recorded video certainly doesn't look like high

Asus EeePad Transformer (TF101) Specifications

Display:	10.1" LED backlit touch-sensitive screen with IPS (1280 x 800) 10 fingers multi-touch, Gorilla glass
Operating system:	Android 3.0 Honeycomb
Platform:	Nvidia Tegra 2
Memory:	LP DDR2 1GB
Storage:	16GB or 32GB EMMC + unlimited ASUS webstorage
Wireless:	802.11 b/g/n, Bluetooth 2.1 + EDR
Camera:	1.2MP (front), 5MP autofocus (rear)
Interfaces:	2-in-1 audio jack (headphone/mic-in); mini HDMI 1.3a port micro-SD card reader; internal microphone; stereo speakers
Sensor:	g-sensor, light sensor, gyroscope, E-compass, GPS
3G Module:	Optional
Flash support:	Yes (downloadable)
Multi-tasking:	Yes
Special App:	ASUS launcher, MyLibrary, MyNet, MyCloud, File manager, PC sync
Battery:	24.4Wh Li-polymer; life 9.5 hours; 16 hours with dock
Size & Weight:	271 x 177 x 12.98mm; 680g (with battery)

These specifications were as supplied by Asus at the press launch. However there appear to be a few minor differences in the sample unit received (eg, Android 3.1, 1.3MP front camera and we're still not sure about that "optional" 3G module). Perhaps the Transformer reviewed was a later model.

This is what sets the Asus Transformer apart from other tablets: the dock/keyboard. The tablet drops into that slot at the top and locks in place.

definition to me.

In fact, the quality of both cameras leaves something to be desired; I found them somewhat inferior to similar resolution cameras on many mobile phones these days. Colours are not particularly good (they're a bit washed out) and they don't look very sharp to me. However, that's only a minor criticism – if you're buying a tablet to use as a camera, you're probably buying the wrong technology!

Like most tablets, the screen image rotates as you rotate the machine. This is accomplished via a three-axis MEMS chip. And it also has a GPS receiver inbuilt which work nicely with the pre-loaded maps and satellite (Google Earth) images.

The docking keyboard

Here is where I believe Asus have made a brilliant marketing decision – and arguably the main reason this computer has created such a stir.

An optional QWERTY keyboard, with tactile keys, transforms the TF101 into what is effectively a netbook computer. Hence the name, "Transformer".

The tablet simply slots into a guide on the edge of the keyboard and locks in place. Once in, the slot becomes a hinge and the keyboard closes onto the tablet just as it would in a notebook PC. To release the tablet from the keyboard, it's simply a matter of sliding a catch over and lifting it out.

It's not just a keyboard, either. As well as adding two USB ports and an SD card slot, it also virtually doubles the battery life from around 8 hours to about 16 hours.

What's more, the keyboard's battery will recharge the tablet battery. If both batteries are fully charged, the Transformer will first take power from the keyboard battery, so the tablet always has as much power as possible for when you want to detach it.

The keyboard includes a touchpad "mouse" and it also sports 17 dedicated "function" keys along the top row. They're not like your usual keyboard F1, F2, F3 etc keys – these are all dedicated to a particular task.

Notebook and netbook keyboards are often (unfairly) criticis ed due to a perceived close key spacing. We've also seen criticism on the web of the Transformer keyboard key spacing –in fact, one of our staff members said exactly that.

In general, (although there are exceptions) this perception is quite wrong and is definitely wrong on the Transformer keyboard. Key spacing from the Q key to the P key is 160mm – compare this to my Microsoft PC keyboard at 170mm. So if you are a touch typist looking for speed, the Transformer keypad won't slow you down.

Overseas, the keyboard is sold as a ~$150 option for both Transformer models; here in Australia it appears that the usual sales method is to bundle it with the 32GB model (TF101B). We'll get to prices in just a moment.

Software

Straight out of the box, the Transformer is loaded with an extensive range of user applications, or shortcuts to them. These range from your typical office apps (document, spreadsheet and presentation in "Polaris Office") through to maps, games (yes, Angry Birds is there!), lots of business, education, medical, video and sound . . .

Put them together and what do you get? The Transformer transformed into a powerful little netbook with just about all the bells and whistles you could ask for. OK, so it doesn't have 3G (yet?) but there are ways around that little dilemma!

When not locked to its docking station, you don't lose any functionality with the tablet (OK, battery life is halved and you lose a USB slot and an SD card slot). But otherwise, it's all at your fingertips – quite literally with the touch-screen display.

we could be here all day listing all of the preloaded and shortcuts to apps.

Some are free, others have a nominal charge (the most expensive I found was less than $30; most are much less, in the $1-$3 range).

And there's nothing stopping you downloading countless thousands of Android apps from a huge variety of sources – again, many are free; most entail a quite nominal charge.

Performance

To be honest, there is not a great deal between the various tablets on the market at the moment – but all the test reports I have seen put the Asus Transformer either at, or near, the top. We didn't have the opportunity to test the Asus against other tablets; ours was more a subjective test than objective. But in most aspects, I was impressed with the way the Transformer worked.

The exception is the cameras – both still and video – they're not as good as I expected. But as I said earlier, you don't buy a tablet PC and expect a Nikon result!

The audio from the inbuilt speakers is definitely nothing to write home about, either. Through earphones or an external amplifier, it's not too bad, as you might expect.

Otherwise I liked its operation, its smoothness, its light weight – in fact, there isn't much not to like about it.

Using Android

If you are used to a Windows-based PC, you may find the learning curve for any Android PC (this one included) a little steep.

While there are many similarities in operation, there are also fundamental differences and if you decide to migrate to Android, you're going to have to unlearn quite a lot – perhaps what the Android community would regard as bad habits anyway!

But there's a bigger consideration if you decide to use the Transformer as you "main" computer – and that's applications. As we mentioned before, there are many thousands of Android applications already but compare that to the millions available in Windows.

You may find that much of your favourite software is simply not yet (or maybe never will be) available in Android, especially if it is at all specialised.

From our research, it would appear that "porting" a Windows application to Android is not a particularly straightforward task, even taking into account that Android is based on the Linux kernel. If commercial software developers can't see a return in porting, they obviously won't bother.

Many Android apps are obviously labours of love by Android devotees who perhaps aren't looking for a big commercial return on their efforts.

For many Transformer users the loss of Windows applications won't particularly matter, given the extensive range of software applications that the Transformer comes loaded with. And it goes without saying that the number of new apps being written for Android will continue to grow as Android use grows.

Maybe there will be something there that will do the job for you; maybe not. But if there is, you're going to need to re-learn it because it will obviously work differently. Perhaps that's a good thing; new applications tend to learn from the mistakes made in old ones!

The Cloud

But all is not lost! Like the vast majority of tablets, netbooks and even smartphones these days, the Asus Transformer is designed not only for stand-alone use but also to work as a Cloud Computer.

Many people are confused by this term so we've prepared a separate panel opposite which (hopefully!) explains it for you.

Suffice to say that the Transformer works with Cloud applications which are meant to be device (or platform) independent.

So you may well find what you want in "the Cloud".

The Transformer has an app called "MyCloud" which Asus describe as a total cloud solution, providing access to digital content such as music, videos and files from the cloud anywhere, anytime. Users can even use MyCloud

Where did the "Asus" name come from?

We were intrigued to learn that Asus comes from the last four letters of Pegasus, the winged horse of Greek mythology, that represents the inspiration of art and learning.

The company's rationale is that Asus embodies the strength, creative spirit and purity symbolised by this regal and agile mythical creature, soaring to new heights of quality and innovation with each product it introduces to the market. So now you know!

So what is "CLOUD COMPUTING"?

It's already the buzzword of the "ones" decade. A recent visit to the CEBIT show in Sydney revealed dozens of vendors offering "Cloud Solutions" and "Cloud Applications". Very few made any attempt to explain what those terms meant because, well, everyone knows what they mean, don't they?

No they don't!

If you Google "Cloud Computing" you'll find hundreds of websites which pose the question, "What is Cloud Computing?" and then many fail dismally in their attempt to answer it – they launch into the savings you'll make or the flexibility you'll enjoy or whatever.

So we'll pose the question again:

What is Cloud Computing?

OK, let's see if we can answer that simply by using a scenario.

At the moment, you're probably using a computer loaded with a whole swag of programs and a big hard disk for storage. It might be on a network where you share your information or perhaps store and retrieve data from a central server. It's even possible that you run your applications software from that central server.

In Cloud Computing, that "server" is "somewhere else". Where? It doesn't matter too much – it's just physically not (normally!) in your office or building. But that server is where most, perhaps all your applications are run from and all your data is stored.

To access it, you simply use an application on your local PC which calls up your particular requirements.

It's called "Cloud" computing because the cloud is representative of "somewhere else". You can't see it, you can't control it, you can simply use it. (The cloud symbol has been used in the telephone industry for decades, simply to depict the same "somewhere else").

Believe it or not, you're probably using a form of Cloud Computing every day, especially if you use any of the "public" email systems such as Hotmail, Yahoo or Gmail, if you use Google or if you use social networking sites such as Facebook, Twitter and even forums and chat rooms.

Think about it: all you do is "log on" to any of these (via the internet) and they operate virtually independently of your computer. All the information is stored elsewhere and control of the system resides elsewhere. You don't know where and don't care where!

Expand this idea a little to a company with say dozens (hundreds?) of computers all working away with their own software. Every application needs to be purchased, licenced and upgraded as necessary. It can be a logistical nightmare.

Not any more. Now it's the Cloud Computing provider who does all that; all you do is pay a monthly fee to the provider for any apps you need and to "rent" some space for your data.

The net result is less powerful (cheaper!) computers in the workplace, none of the software worries and the knowledge that all your information has some of the best backup and security available.

Security! Aaah, that is one of the major concerns of potential Cloud users – and with good reason, following some recent celebrated "hacks" and theft of data. Cloud promoters say that their security is almost certainly a lot better than organisations who maintain their own wide-area networks, simply because they have world's-best practices and the experts to keep it that way.

They also maintain that they offer better redundancy and data integrity because of the way they are set up.

It's not perfect, nothing is (hackers will always try to break into the unbreakable and sometimes succeed). But it can offer significant savings and labour benefits to organisations who use it.

Another big advantage of Cloud Computing is that you no longer need be tied to the same computer, because "The Cloud" is everywhere. As long as you can log onto The Cloud (ie, with appropriate access codes and passwords), you can use it virtually anywhere on earth. If that's via a home broadband connection, or even on your laptop in a resort on the other side of the world, so be it. This has all sorts of implications including that "holy grail", telecommuting or working from your home office.

Is it the ultimate? Of course not – there will always be something newer, better around the corner. But it's pretty exciting and it's right here, right now.

Tablet comparisons: Asus, Motorola, Acer and iPad 2

	ASUS Transformer	Motorola Xoom	Acer 10"	Apple iPad 2
Dimensions(mm)	171 x 276.8 x 6~12.98	167 x 249 x 12.99	177 x 260 x 13.5~6	185.7 x 241.2 x 8.8
LCD	10.1" IPS panel	10.1" IPS panel	10.1" MVA panel	9.7" IPS panel
Resolution	1280 x 800	1280 x 800	1280 x 800	1024 x 768
Multi touch	10 fingers	10 fingers	10 fingers	11 fingers
OS	Android 3.0	Android 3.0	Android 3.0	iOS v 4.3
Processor	NVIDIA Tegra 2	NVIDIA Tegra 2	NVIDIA Tegra 2	Apple A5
RAM	1GB	1GB	1GB	512MB
Built-in Flash ROM	16GB / 32GB	32GB	16GB / 32GB	16GB / 32GB / 64GB
Front Camera	1.2 megapixel	2 megapixel	2 megapixel	VGA (0.3MP)
Rear Camera	5 megapixel	5 megapixel	5 megapixel	720p/30p video (0.9MP)
GPS	Yes	Yes	Yes	Yes
Audio	SRS	n/a	Dolby	?
Flash compatibility	Yes	Yes	Yes	No
USB connector(s)	Yes	Yes	Yes	No
Battery Life	Pad only 9.5 hrs Pad + Docking 16 hrs	10 hrs(6,500mAh)	Not Disclosed	10 hrs(6,500mAh)
Weight	680g	730g	758g	601g

This table, again taken from Asus's press kit, shows the basic specifications of four competing tablet computers. As you can see, there's not a great deal between them – except for that unique docking keyboard on the Asus Transformer.

to remotely access and control any PC or Mac system and access applications or files to extend the versatility of the EeePad Transformer experience.

An app called ASUS Sync is included (or downloadable from Asus website) which synchronises the Transformer with your PC.

Is it a toy?

It's a question one of our staff asked after "playing" with it for a short time. And it's a fair question, too: it's so small it doesn't look like a "real" computer.

While there are huge numbers of game apps available, I would have to say that the Transformer is definitely not a toy.

Yes, it is small but (especially with the dock/keyboard) it's as much a contender for real computer status as any of the netbooks on the market today – and given its versatility, better than most.

One website I browsed reported that "the world has gone mad with tablets" and they weren't talking about Viagra. Every mainstream manufacturer is reported to have tablet models on the drawing board for release this year, or has already done so. Don't be surprised if you decide that your next computer will be a tablet.

Given the Transformer's size and weight, it's perfect for taking with you. With built-in WiFi, you can get online practically anywhere you need to these days – and while it doesn't (yet?) have 3G, a (now very cheap!) wireless broadband dongle can take care of that. Or you can tether it to a 3G phone and away you go!

Amongst a huge range of uses, I also found it particularly handy as an e-reader. I read *a lot* on line and found, again due to its light weight, it's great for reading in bed without disturbing my partner or for sitting in the armchair without a heavy weight on my lap. The display is right up there in clarity and brilliance – I believe as good as the iPad.

Check out the specs panel and you can compare it with the iPad – in most areas, the Transformer is as good or better.

Pricing

Here's the burr under the saddle.

One of the big selling points overseas, apart from offering more features than the iPad, is that the Asus Transformer is around $100 cheaper.

Not so in Australia. Let me explain: In the US, the 16GB Asus Transformer has a retail price of $399; perhaps even a little cheaper in some places (it's already being discounted now that supply is up to scratch). The iPad 2 sells there for $US499. We won't worry about currency conversion because it's close enough to parity.

Here in Australia, for reasons best known to Asus Australia, you'll be hard pressed finding a 16GB Transformer for much less than the recommended retail price – a whopping $599. The iPad2 is $579.

So the Transformer's price advantage is right out the window. In fact, we've even seen them advertised here at $629 (although that might simply be an early supply/demand thing).

The question must be asked, why so expensive?

Even allowing for Australian GST (10%) and maybe a little bit more freight, the price should not be anything like $180 more – and remember we said we weren't worrying about currency conversions – if you do that's another 5% OFF the Aussie price.

It's a better story with the 32GB model. US price: $499 plus docking station/keyboard (~$150) or about $650.00. The "usual" price in Australia, with the docking station, is about $796.00. Strangely enough, the iPad2 32GB (without a keyboard) also sells here for about $796.00

We think Asus Australia are shooting themselves in both feet.

Many posters in the Android forums (eg http://forums.whirlpool.net.au/forum/140) have reported just how easy it is to order online from the US, pay somewhere between $20 and $50 in freight and you'll save a good $100 or more (there is no GST on <$1000 imports).

The Asus EeePad Transformer is a great little product with enormous potential – but with the iPad's marketing clout and their already huge penetration in the marketplace, the Transformer will be lucky to get any foothold in this country without at least *some* price advantage.

That it does not have – and that's a real shame. SC

Need to do a bit of self-diagnosis? Make sure your heart is still beating or check other body sounds? Maybe you would like to sort out some unusual rattles or other noises in your car's engine or other machinery?
This electronic stethoscope will do the job – and you can listen via headphones or a loudspeaker. It has switchable frequency shaping in four bands so you can hone in on sounds which might otherwise be masked out.

Features
- Portable
- Battery supply
- Volume control
- Boost or cut control
- Selectable tone frequency
- Reverse supply protection
- Power and battery condition indicator

Electronic Stethoscope

By JOHN CLARKE

So why have an electronic stethoscope when a traditional cheap and cheerful stethoscope might be all you need?

Well, a conventional stethoscope is OK if you have keen hearing and you are listening in a quiet environment but its sound levels are quite low, particularly at low frequencies.

Secondly, on a cheap stethoscope there is no way of tailoring the frequency response of sound heard at the earpiece (apart from choosing the diaphragm or bell on the chestpiece of a medical stethoscope).

The SILICON CHIP Electronic Stethoscope has plenty of gain – you can adjust the volume level to suit and you can use switchable filtering to cut or boost a particular band of frequencies. As well, it can be connected to headphones or a loudspeaker, in which case more than one person can hear the sounds.

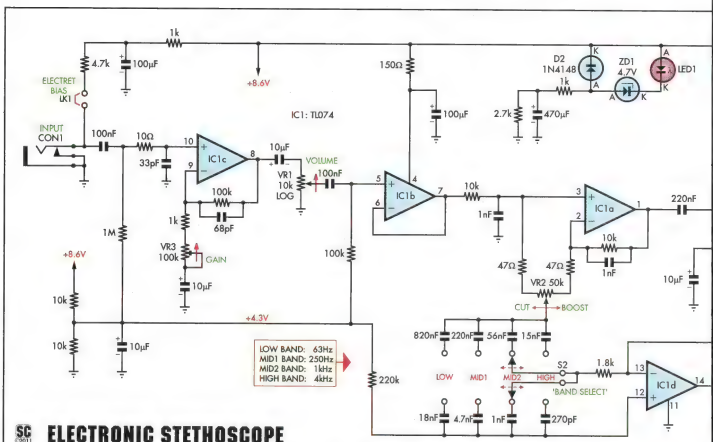
If you wanted to, you could record the monitored sounds and display the waveforms on computer screen.

Our Electronic Stethoscope comprises a chestpiece (sound pickup) that connects to a small amplifier box via a shielded cable. It has a headphone socket, knobs for volume and equaliser (EQ) and switches for power and for frequency band.

The equaliser provides boost or cut in the frequency band selected by the 4-position slide switch.

These bands are centred on 63Hz, 250Hz, 1kHz and 4kHz and are labelled Low, Mid1, Mid2 and High respectively.

To simulate the bell sensor (of a medical stethoscope)



ELECTRONIC STETHOSCOPE

Fig. 1: the circuit is based on two low-cost ICs – an amplifier (IC1a), buffer (IC1b), frequency band selection (IC1c and d) and finally, a power amplifier capable of driving a set of headphones or ear buds (IC2). It's all powered by a 9V battery.

where low frequency sounds are more prominent, the Mid2 band can be selected and the equaliser control set for an amount of signal cut. Or the low band could be selected with the equaliser control set in the boost position. To simulate the chestpiece diaphragm, the high band can be selected and the "EQ" pot set to the cut position.

Alternatively, any one of the bands can be selected by the switch and the equaliser pot can be set to boost or cut. Boosting the frequency band selected will make more prominent any sounds of interest within that band.

Conversely, the cut position will remove prominent sounds in that band that may otherwise mask out the sounds of interest.

The chestpiece is adapted from a low cost stethoscope but with a piezo transducer fitted inside.

For use with car engines or other machinery, the chestpiece is further modified to provide a more direct contact with the piezo transducer element.

Circuit details

The Electronic Stethoscope is based on two low-cost ICs: a TL074 quad op amp IC and an LM386 power amplifier IC. The op amps are used for amplification and filtering of the signal from the piezo element in the chestpiece. The power amplifier drives the headphones or a loudspeaker. The full circuit is shown in Fig.1.

Signal from the piezo element is applied via CON1, 3.5mm socket and a 100nF capacitor to op amp IC1c. The associated 33pF capacitor and 10Ω resistor attenuate high frequencies and thereby reduce the possibility of picking up radio signals. IC1c is biased at +4.3V via the 1MΩ resistor connected to the 10kΩ voltage divider resistors across the 8.6V supply. The 1MΩ resistor also sets the input impedance of the amplifier.

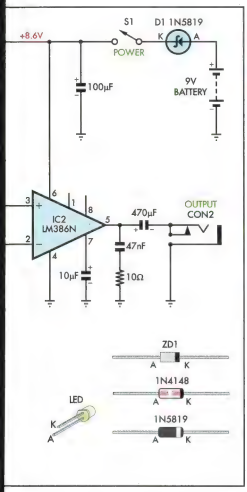
Note that bias for an optional electret microphone is included and is fed via link LK1 and 4.7kΩ resistor to the 8.6V supply via a 1kΩ resistor and 100µF bypass capacitor. (Electret bias is included so that the stethoscope can be used in a different application. See the section entitled "Using the stethoscope as an audio eavesdropper").

IC1c is connected as a non-inverting amplifier with a gain that can range from about two when trimpot VR3 is set at 100kΩ up to 101 when VR3 is set to its minimum resistance. IC1c's output is coupled to the volume control potentiometer, VR1, via a 10µF capacitor.

The output of VR1 (wiper) is fed to IC1b which is connected as a unity gain buffer. The output from IC1b drives the equaliser (EQ) stage consisting of op amps IC1a and IC1d.

SPECIFICATIONS

Supply voltage: ..... 9V @ 12mA quiescent current
Battery life: ..... Typically 30 hours (with alkaline battery)
Selectable bands: .....63Hz, 250Hz, 1kHz and 4kHz
Boost or cut range: ..±15dB



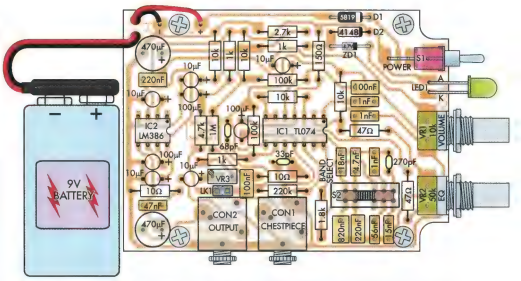


Fig.4: here's how it all goes together on the PCB. Note how the twin wires from the battery snap pass through the front of the board and back out again – that's for strain relieve on the solder joints (they could otherwise snap off). Watch the IC, LED and electrolytic capacitor orientation; also make sure the two pots aren't mixed up. Finally, the jumper for the link (LK1) is only placed in position for use with an electret microphone – it is not used at all for the "normal" piezo version.

Switchable single band equaliser

These two op amps form a single band equaliser which can boost or cut the signals in a defined frequency band selected by the 4-position slide switch, S2.

The concept for the single band equaliser can be seen in Fig.2. In essence, we have an op amp (IC1a) connected as a non-inverting amplifier and a feedback network with a potentiometer (VR2) which sets the amount of boost or cut. The frequency band is defined by the resonant frequency of the series-connected capacitor C1 and inductor L1.

With VR2 wound fully to the left, the tuned series LC circuit is connected to IC1a's input via a 47Ω resistor. At the resonant frequency, the impedance of the LC network is at a minimum. Thus, the signal applied to IC1a will be shunted to ground, reducing the signal at the IC1a output.

When VR2 is rotated to its boost setting, the LC network is connected directly to the inverting (-) input of the op amp via another 47Ω resistor, shunting the negative feedback to ground. At the resonant frequency, the low impedance of the LC network reduces the feedback and the gain of IC1a will increase.

The centre frequency of the circuit can be obtained from the formula:

$$F_0 = \frac{1}{2\pi\sqrt{L\,C_1}}$$

In fact, our circuit does not use an inductor in the equaliser as it would be very large and bulky. Instead we have replaced the inductor with a gyrator. A "gyrator" is a pseudo-inductor using an op amp and a capacitor, as shown in Fig.3.

In an inductor, the current lags or is delayed by 90° with respect to the voltage waveform. With a capacitor, however, the voltage lags the current by 90°.

To simulate the inductor, the voltage lag of the capacitor must be converted to a leading voltage compared to the current. With an AC signal applied to the input of the circuit (Vin) of Fig.3, current will flow through capacitor C2 and the resistor R2.

Because it is connected as a voltage follower, the op amp will reproduce the voltage across R2 at its output.

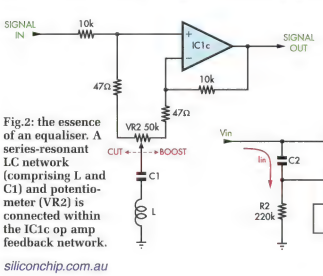


Fig.2: the essence of an equaliser. A series-resonant LC network (comprising L and C1) and potentiometer (VR2) is connected within the IC1c op amp feedback network.

Fig.3 (left): circuitry of a gyrator. The op amp IC1d simulates an inductor by a phase transformation of the current through C2. The resulting inductance is equal to the product of R1, R2 and C2.

The three basic components of our new Electronic Stethoscope. At left is a pair of standard heaphones – it will also work with ear buds but we find ear-covering headphones best, as they mask more external noise. Top right is the "works" while at lower right is the chest-piece, itself made by modifying a low-cost medical (acoustic) stethoscope. Inset top left is the "mechanic's" attachment we made to listen into machinery etc.

This voltage will now cause a current to flow in R1 and this adds to the input current. The resulting total current lags the input voltage by 90°. So as far as the signal source is concerned, the circuit behaves like an inductor.

The value of simulated inductance is given by the equation: L = R1 x R2 x C2. By substituting the gyrator for the inductor in the circuit of Fig.2, we have the basis for a complete equaliser.

The 4-position slide switch, S1, selects different values for C2 and C1 for each of the frequency bands.

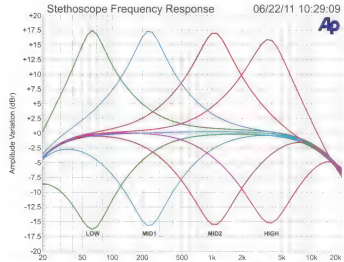


Fig.5: boost and cut graph for each band as set for maximum boost and cut. Note that only one single band can be used at one time in either boost or cut position. Boost or cut can be set to any level between the two extreme boost or cut levels.

Following the equaliser stage, the signal is fed via a 220nF capacitor to the non-inverting input (pin 3) of IC2, the LM386 audio power amplifier. IC2 can provide about 500mW into 8Ω with a 9V supply and distortion is typically 0.2%. When using stereo 32Ω headphones (with the earpieces connected in parallel to give a 16Ω load), the power is about 250mW; more than enough to provide sufficient listening volume.

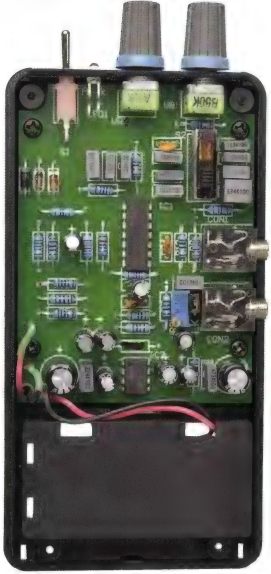
IC2 drives the output load via a 470µF capacitor and a Zobel network, comprising a 10Ω resistor and 47nF capacitor, which helps prevents amplifier instability.

The power for the stethoscope comes from a 9V alkaline battery, with diode D1 providing protection against a reverse polarity connection. A Schottky diode is used due to its low forward voltage loss (about 0.3V compared to a normal silicon diode's 0.6V).

LED1 has two functions: to show power 'on' and to show battery condition. It operates as follows. When power is first applied, current for the LED flows through the 4.7V zener diode (ZD1), the 1kΩ resistor and the discharged 470µF capacitor. If the battery is fresh, the 9V battery provides 8.7V at the anode of LED1. This voltage is reduced by about 1.8V by LED1 and 4.7V by ZD1, leaving 2.2V across the 1kΩ resistor. LED1 lights with 2.2mA.

At lower battery voltages, there is less voltage across the 1kΩ resistor so the LED is dimmer. At a battery voltage of 7V, there is about 0.2V across the 1kΩ resistor and the LED barely lights.

As the 470µF capacitor charges up, the LED current is reduced to much lower level, set by the 2.7kΩ resistor across the capacitor. This indicates that the Electronic Stethoscope is switched on without wasting significant power. When power is switched off, diode D2 discharges the 470µF capacitor so



Inside the assembled Electronic Stethoscope "works", reproduced here close to same size. Use this in conjunction with the component overlay (fig.4).

the circuit is again ready to indicate the battery charge state when it is turned back on.

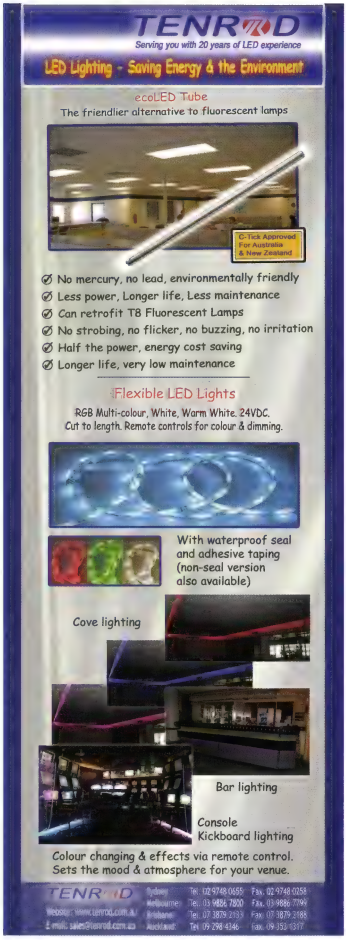
The 8.7V supply is connected directly to IC2 but it is fed to IC1 via a 150Ω resistor. A 100µF capacitor decouples this supply and removes any supply modulation from IC2 which could otherwise cause instability. This would take the form of audible "motor-boating".

Construction

With the exception of the piezo mounted on the chestpiece, all the Electronic Stethoscope components are accommodated on a single PCB, coded 01108111 and measuring 65 x 86mm. In turn, the PCB is housed in a black plastic "remote control" case measuring 135 x 70 x 24mm.

The PCB is designed to mount onto the integral mounting bushes within the box. Make sure the front edge of the PCB is shaped to the correct outline so it fits into the box. It can be filed to shape if necessary using the PCB outline as a guide.

Begin construction by checking the PCB for breaks in tracks or shorts between tracks or pads. Repair any defects, if necessary. Check the sizes for the PCB mounting holes and for the battery leads. These are 3mm in diameter.



End-on view showing the three controls (Eq, Volume and Power) on the end panel and the four-way filter band selection switch on the front panel.

The component overlay for the PCB is shown in Fig.4

You can start assembly by the inserting the resistors. Check each resistor value against the colour code table as you go and double-check with a digital multimeter. Next, install the two PC stakes followed by the diodes, mounted as shown.

IC1 & IC2 can be directly mounted on the PCB, or if you wish can be mounted on DIP8 sockets. When installing ICs (and sockets if you use them), take care to orient them correctly. Orientation is with the notch positioned as shown.

Switch S2 does not mount directly onto the PCB but is raised off the PCB using a 6-way dual row pin header. Remove a pair of pins so that there is a row of three pins, then a gap then two pins on each side of the DIL header.

The header pins are longer at the top than the bottom. Push them down so that the tops are 5mm above the bottom of the plastic section and solder it in the switch mounting position. The switch is mounted by soldering its pins to the top of the header pins. The switch must be oriented correctly with the row of three pins toward the volume pot (VR1). The top of the switch body should be 12mm above the PCB.

The capacitors can be mounted now. The electrolytic types must be oriented correctly – the polarity is shown on the component overlay. Make sure these capacitors are placed in the PCB so their height above the board surface is no more than 12.5mm otherwise the lid of the case will not fit correctly.

The potentiometer (VR2) and the PCB mounted switch S1 can also be fitted now, along with the 3.5mm sockets.

LED1 mounts horizontally but at a height of 6mm above the PCB. Bend its leads at 7mm back from the base of the LEDs at 90° making sure the anode lead is to the left.

When assembled, the PCB is secured to the base of the case using four M3 x 6mm screws that screw into the integral mounting bushes in the box. Before putting this in place, drill out the small front panel for the LEDs, potentiometer and switch. A drill guide is provided with the front panel label.

Holes are also required in the base and case lid for the 3.5mm sockets. A rat-tail file can be used to make these cut outs.

The panel label for this project can be downloaded from the SILICON CHIP website (www.siliconchip.com.au). Go to the downloads section and select the month and year of publication.

When downloaded, you can print onto paper, sticky backed photo paper or onto plastic film. Paper labels need protection, so cover them with self-adhesive clear plastic or, best of all, hot laminate film.

When using clear plastic film (overhead projector film) you can print the label as a mirror image so that the ink is behind the film when placed onto the panel. Once the ink is dry, cut the label to size.

The paper or plastic film is glued to the panel using an even smear of neutral cure silicone sealant or spray contact adhesive. If you are glueing a clear plastic film label to a black coloured panel, use coloured silicone such as grey or white so the label can be seen against the black.

A rectangular hole in the panel is required directly above the slider switch S2. The positioning for this is shown on the label. This shape can be first drilled in the plastic lid and then once the panel label is affixed, the cut the panel hole out using a sharp hobby knife. The top of the switch can be coloured black using a permanent marker pen to improve the appearance through the switch hole.

If you require the Stethoscope to be secured to a belt, a suitable belt clip is available from Altronics (cat no H0349). Contact www.altronics.com.au

Chestpiece

The chestpiece for the Electronic Stethoscope is cannibalised from a commonly-available (and low cost) acoustic medical stethoscope. Ours came from Jaycar Electronics (www.jaycar.com.au), cat no QM7255 @ $14.95 but most chemists and medical supply houses have them.

You can pay a lot more for a stethoscope – for example the Littman Cardiology III, manufactured by 3M, sells for more

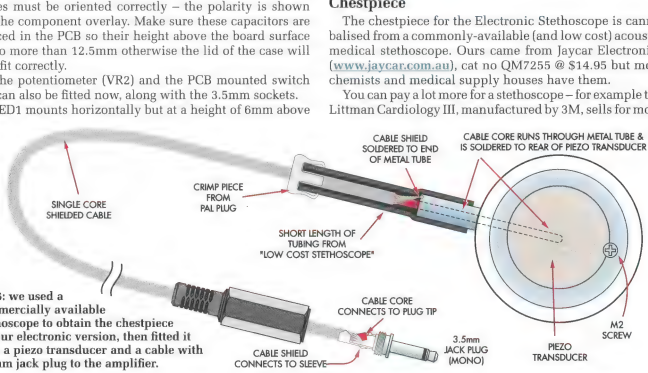


Fig.6: we used a commercially available stethoscope to obtain the chestpiece for our electronic version, then fitted it with a piezo transducer and a cable with 3.5mm jack plug to the amplifier.

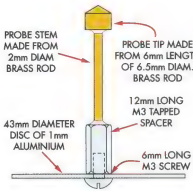


Fig. 7: to listen in to engines and other equipment you'll need something like this probe. It transmits vibrations etc direct to the piezo transducer of the chestpiece.

than $150. But we're not interested in specialised models, the common or garden-variety stethoscope is what we're after.

The following applies specifically to the Jaycar model but you will probably find that most of the low-cost stethoscopes use a similar method of construction.

The diaphragm section is removed from the chestpiece to access the inside of the casting. Unscrewing the outer annulus from the rear casting does this.

The piezo element from a piezo transducer is used as the detector and is placed within the chestpiece diecast housing.

The piezo transducer is available from Jaycar, cat. no AB-3440 or from Altronics, cat no S 6140.

We did test the stethoscope using an electret microphone (Jaycar AM4008) for the chestpiece pickup sensor. This was a very small microphone at 6mm in diameter and 3.5mm deep that fits within the back of the diecast moulding.

This proved to be unsatisfactory for this application, although there was nothing wrong with the microphone itself.

The main problem was that it would detect far more than was required for a stethoscope including detection of noises from adjacent rooms. The use of an electret microphone, however, is ideal for use as an eavesdropper. See the separate section concerning its use.

A piezo element proved to produce a much better result. The piezo element is removed from its plastic transducer housing.

To do this, firstly remove the backing

Parts List – Electronic Stethoscope

1 PCB, coded 01108111, 65 x 86mm
1 remote control case 135 x 70 x 24mm (Jaycar HB5610 or equivalent)
1 panel label 50 x 114mm
1 9V battery
1 9V battery clip lead
1 low cost stethoscope (Jaycar QM7255) used for parts
1 miniature PC mount SPDT toggle switch (Altronics S 1421 or equivalent) (S1)
1 DP4T switch (Tyco Electronics STS2400PC04) (Element14 Cat.1291137) (S2)
1 10k log potentiometer, 9mm square, PCB mount (VR1)
1 50k linear potentiometer, 9mm square, PCB mount (VR2)
2 knobs to suit potentiometers
2 PC mount 3.5mm stereo sockets (CON1,CON2)
1 3.5mm mono line jack plug
1 DIP8 IC socket (optional)
1 DIP14 IC socket (optional)
1 piezo transducer (Jaycar AB-3440, Altronics S 6140)
1 PAL (Belling Lee) line plug with plastic housing (Jaycar PP0600) (required for the metal crimp shield connector)
4 M3 x 6mm screws
1 M2 x 3mm screw (or a cut down M2 x 8mm screw)
1 6-way DIL pin header
1 2-way pin header with 2.54mm spacing (with jumper shunt)
2 PC stakes
1 60mm length of 10mm diameter heatshrink tubing
1 750mm length of single core shielded cable

Semiconductors
1 TL074 quad op amp (IC1)
1 LM386N amplifier (IC2)
1 1N5819 1A Schottky diode (D1)
1 1N4148 switching diode (D2)
1 4.7V 1W zener diode (ZD1)
1 3mm high intensity red LED (LED1)

Capacitors
2 470µF 16V PC electrolytic
3 100µF 16V PC electrolytic
5 10µF 16V PC electrolytic
1 820nF MKT polyester
2 220nF MKT polyester
2 100nF MKT polyester
1 56nF MKT polyester
1 47nF MKT polyester
1 18nF MKT polyester
1 15nF MKT polyester
1 4.7nF MKT polyester
3 1nF MKT polyester
1 270pF ceramic
1 68pF ceramic
1 33pF ceramic

Resistors (0.25W, 1%)

1 1MΩ	1 220kΩ	2 100kΩ
4 10kΩ	1 4.7kΩ	1 2.7kΩ
1 1.8kΩ	3 1kΩ	1 150Ω
2 47Ω	2 10Ω	

1 100kΩ multiturn top adjust trimpot (VR3)

Miscellaneous
Earphones or headphones, neutral cure silicone sealant, solder.

Mechanic's Stethoscope – Optional Parts

1 43mm diameter circle of 1mm aluminium
1 M3 x 12mm tapped brass spacer
1 M3 x 6mm countersunk screw
1 brass rod 2mm diameter x 40mm long with a 6mm brass spacer tip ***or***
1 top end from a telescopic antenna

Audio Eavesdropper – Optional Parts

1 electret microphone insert (9.5mm diameter) (Jaycar AM-4010 or sim)
1 300mm length of single-core shielded cable
1 3.5mm mono line plug
1 IP68 waterproof gland for 4-8mm diameter cable
1 plastic cylinder 125ID x 157mm long (eg empty 100 x CD container) or similar (see text)
1 timber handle 65 x 115mm (eg, pine off cuts or similar)
2 wood screws (to secure handle)

These three photos show, respectively (from left) the disassembled chest piece with the piezo fitted; the reassembled chestpiece with the cable going off to the amplifier fitted into a short length of the tubing from the original stethoscope and finally a close-up of the "clamp" (actually the wire clamp from a TV cable plug) used to hold it all together.

piece from the housing to expose the transducer. The transducer is easily prised out as it is glued to the housing with a soft rubber-based adhesive. Take care not to crack the piezo element.

Wires connected to the transducer are removed by melting the solder from the metal disk and piezo element itself. Remove the solder with some solder wick.

The piezo element is attached to the chestpiece using an M2 x 3mm screw that is tapped into the chestpiece casting. Drill a 2mm hole in the edge of the transducer but away from the piezo material itself and align the transducer central to the chestpiece housing.

Mark out where the mounting hole is required. Drill a 1.5mm hole (1/16") and screw the M2 screw into the hole. You may need to file a small notch along the M2 screw thread to act as a makeshift thread cutter if the screw does not enter the hole easily. (Of course, if you happen to have an M2 tap, use that!)

Once the hole is 'tapped', remove the screw. The piezo sensor is placed onto the chestpiece housing with the piezo element facing inward.

The core wire of the shielded cable passes through the metal tubing of the chestpiece and is soldered to the centre of the piezo element.

The shielding wire is soldered to the end of the metal tube after firstly filing out a small flat landing on the side of the tubing to allow for a solder joint. Secure the transducer with the M2 screw.

A smear of neutral cure silicone sealant (eg, roof and gutter sealant) is applied around the outside of the transducer to form an air seal to the chestpiece housing.

A short (60mm) length of the tubing from the low-cost stethoscope is cut and slid over the shielded cable and onto the metal tubing of the chestpiece. The tubing is crimped to the shielded cable wire – we used the crimp section of a PAL (Belling Lee connector) placed over the tubing.

This is squeezed down over the tubing to grip the shielded cable in place within the tubing. A 20mm length of 10mm diameter heatshrink tubing is shrunk down over the section to hold the crimp fingers closed.

The diaphragm and annulus can now be reattached to the chestpiece housing by screwing this back together.

The opposite end of the shielded cable is terminated to a 3.5mm mono jack plug.

Mechanic's stethoscope attachment

For the mechanic's attachment, we used a 43mm diameter disk of 1mm aluminium to replace the flexible diaphragm of the chestpiece.

This means that the annulus is unscrewed and the flexible diaphragm removed by pressing it out with using your fingers.

A rod attaches through the centre of this aluminium disk to provide contact with the machinery. We supported our rod using an M3 tapped brass spacer secured to the disk with an M3 x 6mm screw. To this spacer is soldered a brass rod with a tipped end.

We used the end from a discarded telescopic antenna for the rod and soldered this to the 12mm spacer. The rod is 60mm long but it could be longer than that if you need it to be.

An alternative tip could be made from a length of 2mm diameter brass rod and a 6mm long brass standoff. These parts are then soldered together.

The aluminium disk is held in place

RESISTOR COLOUR CODES

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	4.7kΩ	yellow purple red brown	yellow purple black brown brown
❑	1	2.7kΩ	red purple red brown	red purple black brown brown
❑	1	1.8kΩ	brown grey red brown	brown grey black brown brown
❑	3	1kΩ	brown black red brown	brown black black brown brown
❑	1	150Ω	brown green brown brown	brown green black black brown
❑	2	47Ω	yellow purple black brown	yellow purple black gold brown
❑	2	10Ω	brown black black brown	brown black black gold brown

Capacitor Codes

Value	μF Value	IEC Code	EIA Code
820nF	0.82μF	820n	824
220nF	0.22μF	220n	224
100nF	0.1μF	100n	104
56nF	0.056μF	56n	563
47nF	0.047μF	47n	473
18nF	0.018μF	18n	183
15nF	0.015μF	15n	153
4.7nF	0.0047μF	4n7	472
1nF	0.001μF	1n	102
270pF	-	270p	271
68pF	-	68p	68
33pF	-	33p	33

using the anulus in the same way as the diaphragm.

Testing

Testing can be done with the 9V battery connected. Apply power and check that the power LED momentarily lights brightly when switched on and then dims.

Wind the VR1 volume control fully anticlockwise and set the tone control to mid position. This will prevent IC2 from producing large signal levels with no input connected. This allows DC voltages to be tested without being masked by a large AC signal.

For a 9V battery supply, we measured 8.7V at the cathode of D1, 7.7V at pin 4 of IC1 and 8.7V at pin 6 of IC2 with the multimeter's negative probe connected to the casing of one of the 3.5mm jack sockets. A half supply voltage of around 4.3V should be at pins 1, 7, 8, and 14 of IC1 and at pin 5 of IC2.

Make sure the jumper link (LK1) for the electret microphone bias is not inserted for the piezo element of the chestpiece.

Connect the chestpiece and headphones or earpieces to the Stethoscope. Set the volume about mid way and adjust VR3 for a suitable level of volume when monitoring the heart beat on the left side of your chest. Rotate VR3 clockwise for more gain and anticlockwise for less gain.

Check that the tone can be adjusted to boost and cut the selected band of frequencies. This will be evident on the low setting as the heart beat thump is boosted or cut. On the high band more hissing sound will be produced on boost but reduced on cut.

For an idea of what various body sounds make, log onto www.easyauscultation.com. You can then try and find those sounds using your SILICON CHIP Electronic Stethoscope.

Using the stethoscope as an audio eavesdropper

The stethoscope can be used to monitor sounds from a distance using an electret microphone mounted in an open ended container instead of the piezo element within the chestpiece. With this setup you can listen to bird or animal calls (or virtually anything else) at a distance.

The container provides directional sound response, where sound enters the open ended container to be received by the microphone.

Designing your own single-band equaliser

While most users will be satisfied with the four frequency bands selected for the equaliser, there may be some who require different bands. To satisfy this, we have included a method to design your own equaliser section.

Fig.9 shows the typical bandwidth of an equaliser section under boost. The centre of the band is designated F_0 while the frequencies where the response is 3dB down from the F_0 level are shown as F_1 and F_2.

To design for a particular frequency band you can use the equation:

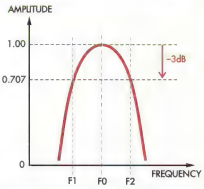


Fig.9: typical bandwidth of an equaliser section under boost.

$$L = \frac{1}{4\pi^2 C_1 F_0^2}$$

This is to obtain a value for the inductance L, using selected values for C1 and F0. The equation is just a rearrangement of the standard

$$F_0 = \frac{1}{2\pi\sqrt{L C_1}}$$

Knowing the inductance enables us to calculate the required value for C_L. Use the equation

$$C_L = \frac{L}{R_1 R_2}$$

For our circuit we used a 1.8kΩ resistance for R_1 and 220kΩ resistance for R_2.

The Q of the circuit determines the two frequencies either side of F_0 where the signal drops off in level by 3dB. You can calculate the Q using this equation:

$$Q = \frac{2\pi F_0 L}{R_1}$$

The Q is also found using the equation

$$Q = \frac{F_0}{F_2 - F_1}$$

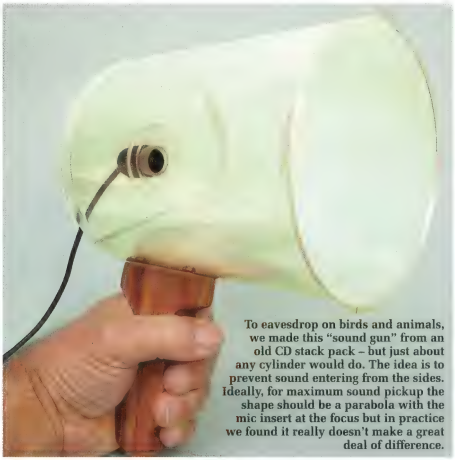
although the equations to find F_1 and F_2 are more difficult. A useful calculator to find F_1 and F_2 is at:

www.sengpielaudio.com/calculator-cutoffFrequencies.htm

The tables below show the components used in the stethoscope, the inductance, Q and F_1 and F_2 for the four bands. You can use these values to practice calculating the values for L and C_2.

F_0	C_L	R_1	R_2	C_1
63Hz	18nF	1.8kΩ	220kΩ	820nF
250Hz	4.7nF	1.8kΩ	220kΩ	220nF
1kHz	1nF	1.8kΩ	220kΩ	56nF
4kHz	270pF	1.8kΩ	220kΩ	15nF

Required F_0	Calculated F_0	Q	F_1	F_2	L
63Hz	65Hz	1.62	48Hz	88Hz	7.13H
250Hz	248Hz	1.61	188Hz	337Hz	1.86H
1kHz	1068Hz	1.49	768Hz	1485Hz	396mH
4kHz	3.974kHz	1.53	2.882kHz	5.479kHz	107mH



To eavesdrop on birds and animals, we made this "sound gun" from an old CD stack pack – but just about any cylinder would do. The idea is to prevent sound entering from the sides. Ideally, for maximum sound pickup the shape should be a parabola with the mic insert at the focus but in practice we found it really doesn't make a great deal of difference.

Sounds coming from the side and rear of the container are reduced in level before reaching the microphone.

Our CD pack sound gun

Construction is straightforward and is shown the photo and in Fig.8. It's not at all critical – you can use whatever is available.

The closed end of the cylinder is drilled out to accept the IP68 gland. This gland neatly houses the electret while the clamp end secures the shielded cable.

Strip the ends of the shielded cable and solder the wires of one end to the microphone insert connection pads. The shielded wires connected to the insert's case pad and the inner wire to the other pad.

The opposite wire end passes through the gland and is clamped down with the electret inserted into the open gland end. The wire is then terminated to a 3.5mm mono jack plug.

A handle was fashioned from an off cut of timber (we reshaped the decorative top section of a cyprus pine picket) and secured this to the side of the cylinder with self tapping screws.

The shape of the handle is not critical so long as it is comfortable to hold. The handle can be finished with olive oil rubbed into the timber before wiping off the excess.

The unit is now ready to test. Plug into the Electronic Stethoscope and note that for this application (or any other using the electret microphone), the electret bias needs to be selected by inserting LK1.

A parabola?

For maximum concentration of sound at the microphone, a parabolic dish should be used with the microphone mounted at the focal point.

We've used a number of different parabolic or near-parabolic shaped dishes in the past.

Design of the pickup using a 'parabolic' shaped dish and electret microphone is shown in the Ultrasonic Eavesdropper article from August 2006 by Jim Rowe. While that design was to receive ultrasonic sounds and convert them to the normal audio band, the pickup arrangement is the same for the audio sound band.

One alternative parabola which we haven't tried (but should be near perfect!) is a metal cooking wok, available quite cheaply from oriental food suppliers. To find the focal point, shine a single-point light source (eg, a LED) into the wok along its centre line. As you move it in and out, at one point the light will appear to "fill the dish" – that's the focal point. (See "Ask Silicon Chip" November 1994, page 93).

We'll leave the mechanical arrangement for mounting the microphone up to you. SC

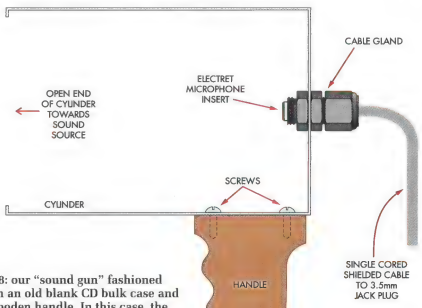


Fig.8: our "sound gun" fashioned from an old blank CD bulk case and a wooden handle. In this case, the electret microphone is used rather than the piezo – but make sure that LK1 is in place on the PCB to provide bias voltage for the electret. It won't work otherwise!

Is your hip-pocket nerve hurting?

We know how you feel – prices seem to be going up all the time.

But you can save money by taking out a SILICON CHIP subscription.

A 12-month subscription will get you 12 issues for the price of less than 11!

For an even bigger discount, a 2-year subscription gets you 24 issues for the price of 20!

Better still, a 2-year subscription gives you longer protection against price rises in the future.

Count the advantages:

- It's cheaper – you $ave money!
- It's delivered right to your mail box!
- You can always be sure you'll receive it!!
- We pick up all the postage and handling charges!!!
- You will never miss an issue because it's sold out (or you forgot)!!!!

6 MONTHS *SILICON CHIP*: $52.00

12 MONTHS *SILICON CHIP*: $97.50

24 MONTHS *SILICON CHIP*: $188.00

*These prices and comparisons refer to Australian subscriptions. Other countries are subject to exchange rates – please see page 102 of this issue.

Safely Removing Solder Fumes

...and other pollutants

We review the Hakko FA-430 fume extractor: what a clever little sucker!

These days, with OHS regulations backing up the natural desire for a safe workplace, removal of the fumes from soldering and other operations is not just desirable, it's essential.

Fume extractors have been around for quite a while – but the ones we usually see are not much more than toys. The Hakko FA-430 is most certainly no toy!

For a start, it's big. No, let's rephrase that. It's **BIG**! At 330 x 366 x 343mm and weighing in at a hefty 7.5kg, it puts to shame those little desk-bound sniffers.

But size means nothing if it isn't backed by performance. We'll look at this in a bit more detail shortly but the FA-430 is capable of drawing more than four cubic metres of air (and their particulates) through its filters each minute.

But it does it quietly. You'd expect this amount of suction to have noise not too far short of an A-380 at take-off – but the FA-430 has a maximum noise level of just 53dB(A) – that's just 3dB more than the "yardstick" quiet office measurement of 50dB(A).

In fact, the FA-430 has three levels of suction – on the lowest setting it measures just 44dB(A) while moving 2.8m^3 per minute.

On medium, that increases to 50dB(A) and 3.7m^3 while the high setting, as mentioned above, is 43dB(A) and 4.7m^3.

But all that doesn't mean much if it lacked in the filtration stakes. Needless to say, it doesn't! Have a look at the graph shown on the opposite page. As you can see, with an amazing 99.97% minimum efficiency, the FA-430 filters particles down to just 0.3µm. That takes in just about all solder smoke and oily smoke, most cigarette smoke, pollens, cloud/mist, airborne dust and significant other airborne pollutants.

It will even filter out bacteria from the airflow – though unfortunately not viruses, which are very much smaller.

by Ross Tester

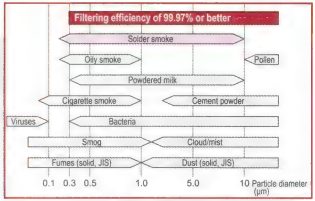
Powerful brushless motor

It does all this with a very quiet 120W brushless motor powering the fan which pulls the fumes through a two-stage filter.

The motor provides 1500Pa of static pressure which is basically stable under all conditions.

The filters have automatic notification when they need changing.

This is actually a very clever part of the story in itself: the sensors count the number of fan revolutions to deter-



The Hakko FA-430 air-purifying fume extractor, shown here with its two-stage filter removed. There are two inlet ducts on the top of the unit; you can use both or one depending on your requirements.

mine how long the extractor has been in use – but also senses the airflow through the filters in case they've been prematurely clogged.

The first stage filter eliminates 65% of particles 0.3μm or larger while the main filter eliminates 99.97%.

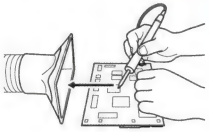
We said there's a two-stage filter. In a way, it's actually a three-stage because if you look carefully at the photo opposite, you'll see a very fine "hair net" over the duct inlet which stops the FA-430 "vacuuming" anything off you workbench!

Ducting

The FA-430 is sold without the ducting shown opposite because every work situation is different; therefore every customer will want to make up their own minds about the ducting to be fitted.

Ducts can be lengthened, bent into different shapes (and will maintain that length or shape) to allow them to be placed exactly where they are required.

Hakko recommend the duct end be placed on the work bench alongside the work for maximum efficiency and



minimum chance of the air conditioning interfering with the airflow.

As you can see on the top of the unit in the photo above, there are two inlet "ports" – you can choose to have one or both of these in use.

Maximum airflow is achieved when both ports are used. A cap is provided to block one port off should it not be required.

A single duct reduces the maximum capacity slightly – to 4.1m^3 per minute.

Another option is the use of a benchtop hood which stops smoke escaping upwards.

In use

It doesn't take any time at all to set up and even less time to get going. And it is quiet! You'll barely notice it over background noise from more than a few metres away.

We never got to the stage of requiring filter replacement but we were assured that it was also very easy and very quick.

If you're at all worried about solder fumes (leaded or not!) or any of the other fumes that you might experience in the workshop (whether business or advanced hobbyist), or you'd simply like to keep the air as clean as possible around you, the Hakko FA-430 would be a very good investment. *SC*

Where from, how much?

Please contact HK Wentworth Pty Ltd for further information
Tel [02] 9938 1566, email sales@hkwentworth.com.au.
The FA-430 has a recommended retail price of $1280.00 Hakko soldering equipment is available through distributors in Australia and New Zealand.

Digital Spirit Level

By ANDREW LEVIDO

This project is really on the . . . errr . . . level. It's an inclinometer, an electronic version of the old spirit level except that this one gives a digital readout of the angle of any flat surface in 0.1° increments from 0-360°. A MEMS accelerometer chip, as found in tablets and smart phones, is at the heart of the project.

MOST OF US HAVE a spirit level somewhere in our shed or garage. These handy devices have been around since the mid 1600s, although the modern form of the device dates from the 1920s. A simple air bubble in a slightly curved tube of coloured alcohol can indicate horizontal or plumb (vertical) with surprising accuracy.

Often a quick check for plumb or level is all that is needed but if you want to measure the actual angle you need an inclinometer. You can buy a digital one for up to a couple of hundred dollars or build one yourself for less than $40, thanks to the plummeting costs of MEMS accelerometers.

MEMS (Micro Electromechanical Systems) technology is finding its way into all sorts of consumer electronics these days. Your tablet or smart phone has a MEMS accelerometer so it knows whether you are holding it in portrait or landscape orientation. Handheld game controllers use both accelerometers and gyroscopes to detect how they are waved, shaken, pointed or flicked. Even my universal remote controller uses one to turn on its LCD when I pick it up.

The inclinometer described in this article uses a typical MEMS chip; the Freescale Semiconductor MMA8451Q. This tiny 16-pin surface-mount device includes a 14-bit 3-axis accelerometer together with a sophisticated DSP (Digital Signal Processor) and an I^2C interface, all for less than $10. Add a low-cost PIC microcontroller, four 7-segment LED displays and a handful of common components and you have all that is necessary for a pretty useful little instrument.

Form factor

Our inclinometer has a form factor that's similar to a small spirit level and can measure angle of tilt with an

accuracy of 0.1° over the full 360° of rotation. Operation could not be simpler. Just pick up the device and give it a shake to bring it to life, then place it on the surface you want to measure. It will stay awake while ever it senses movement and it will automatically turn off after 30 seconds of inactivity.

How it works

The inclinometer measures its orientation with reference to the acceleration due to gravity which, conveniently for us all, always points straight down. We nominate the side-to-side horizontal axis of the accelerometer as "x", the top-to-bottom axis as "y" and the front-to-back axis as "z".

If the accelerometer is level, gravity will be perfectly aligned with the y axis. However, when tilted as shown in Fig.1, there will be components of gravitational acceleration (ie, G x sinθ and G x cosθ) along both the "x" and "y" axes, depending on the tilt angle.

Using trigonometry, we could calculate the angle of tilt from the measured acceleration along the x or y axis, as long as we knew the gravitational acceleration. Unfortunately, this varies from the nominal 9.8ms^2 depending on location, since the Earth is neither perfectly spherical nor uniformly dense.

Fortunately, we can use the trigonometric identity **tanθ = sinθ/cosθ**, to solve our problem. If we take the inverse tangent (arctangent) of the ratio of accelerations along the x and y axes, the gravity terms cancel out and we arrive at the angle of inclination using only the acceleration values.

So the angle can then be determined by using the formula **θ = atan(x/y)** where x and y are the measured accelerations along the two axes.

There is another complication however. If the inclinometer tilts around the x-axis (ie, the x-y plane is no longer vertical), a component of the acceleration due to gravity appears on the z-axis, and the components along the x and y-axes reduce. Ultimately, with the inclinometer lying flat on its back, the x and y components reduce to zero, as all of the acceleration now acts in the z-direction. The falling amplitude of the x and y accelerations as the x-y plane tilts about the x-axis progressively reduces the accuracy of the measurement.

The digital inclinometer described here can maintain 0.1° accuracy, up to the point where the tilt about the x-axis reaches ±45°. The microcontroller therefore keeps track of all three angles, and displays four dashes in place of the measured angle if this level of accuracy cannot be guaranteed.

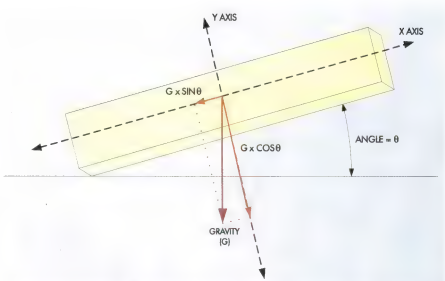


Fig.1: the accelerometer measures the component of the acceleration due to gravity acting on each of the three axes. These components are trigonometrically related to the angle of inclination (see text). Note that the z-axis has been omitted from this diagram for clarity.

Wake & sleep modes

As described above, the main ICs in the inclinometer are in a low-power deep sleep mode when it is not being used and "wakes up" when its senses movement. It remains awake until it senses that it has not moved for about 30 seconds. The MMA8451Q's built-in DSP looks after the detection of movement and the consequent transition between wake and sleep modes. This is just one of the many features of the chip; see the panel titled "Inside the MMA8451Q" for further information on this device.

The DSP algorithm considers motion to be an acceleration that exceeds a programmable threshold for a programmable period of time. Optionally, the acceleration signals can be high-pass filtered first, to eliminate static effects (such as gravity). In addition, motion detection can be enabled on each axis independently.

We set the motion sensitivity threshold fairly low while the unit is awake so that relatively small movements suffice to keep it that way. Conversely, in the sleep mode, the sensitivity is reduced so that a solid "air swing" is required to wake the inclinometer up. This prevents the device from being woken up by every small knock or vibration, as might be experienced in a moving vehicle for example.

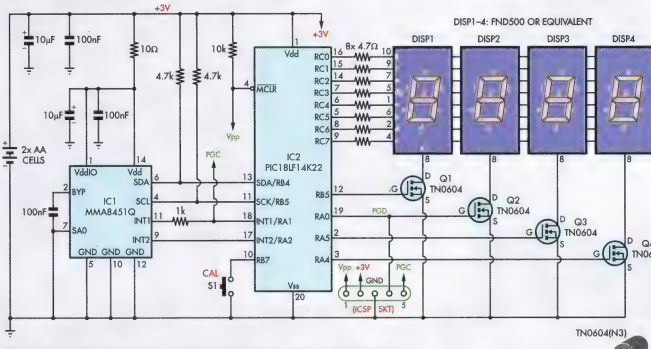
Circuit description

The circuit diagram in Fig.2 shows that the Digital Inclinometer uses just two chips – the MEMS accelerometer (IC1) and a PIC18LF14K22 microcontroller (IC2). The latter drives the anodes of the four 7-segment LED displays directly and the common cathodes indirectly via four Mosfets (Q1-Q4).

The whole circuit is powered directly from two AA batteries, with 10µF and 100nF capacitors providing bulk filtering and high-frequency bypassing respectively. The supply for the accelerometer (IC1) is further filtered by a 10Ω resistor and 10µF and 100nF capacitors, preventing any ripple generated by driving the display from affecting accelerometer measurements.

The PIC micro communicates with the accelerometer using an I^{2}C bus (pins 6 [SDA] & 4 [SCL] of IC1) and two interrupt lines (pins 9 & 11 of IC1). Two 4.7kΩ resistors are used as the usual "pull-ups" for the I^{2}C bus.

The accelerometer is configured to generate a negative-going interrupt pulse on pin 11 (INT1) each time a new acceleration sample is available. Similarly, a negative-going interrupt pulse appears on pin 9 (INT2) of the



INCLINOMETER (ELECTRONIC 'SPIRIT LEVEL')

Fig.2: the circuit for the Inclinometer. The accelerometer (IC1) interfaces with the microcontroller (IC2) over just four lines – two for interrupt signals (pins 9 & 11) and two for the I²C bus (pins 4 & 6). The ICSP connector is not necessary if your microcontroller is supplied pre-programmed.

accelerometer whenever it detects movement, or changes between sleep its wake states.

Pin 18 (RA1) on the PIC microcontroller serves double-duty, functioning both as an interrupt input and as the clock input for in-circuit programming. The 1kΩ resistor is required to ensure that the in-circuit serial programmer (ICSP) interface can drive pin 18 without interference from the accelerometer, for programming the micro. The ICSP data input is shared with pin 19, one of the digit driver outputs. No similar resistor is required here because the Mosfet gate is high impedance and won't affect programming.

The display is a classic multiplexed common-cathode 7-segment arrangement. The eight 4.7Ω resistors on pins RC0-RC7 provide current limiting for the segment LEDs, although in reality the microcontroller outputs themselves limit the drive current to about 20mA per segment. Mosfets Q1-Q4 are used to drive the digits' common cathodes, rather than the usual bipolar transistors, because they can provide a very low "on" resistance even when driven at a low voltage. With only 3V to play with (less if the battery is discharged), we can't afford the few hundred millivolt drop that bipolar transistors would exhibit.

The firmware

The firmware is fairly straightforward. The main program sets up the microcontroller peripherals, configures the accelerometer and then enters an endless loop. From there on, everything occurs in one of four interrupt service routines. One interrupt, triggered by an internal timer, multiplexes the display. The interrupt occurs every 5ms which defines the on-time for each digit. It therefore takes 20ms to display all four digits, for a 50Hz refresh rate.

The second interrupt service routine is triggered by a falling edge on pin 18 of the micro, indicating that new accelerometer data is available. When the accelerometer is awake, this occurs every 640ms. The firmware reads the new data via the I²C bus, calculates the angle, subtracts the offset value stored in EEPROM and updates the display (more on the offset value later).

The third interrupt service routine is triggered by a falling edge on pin 17. This indicates either that the accelerometer has switched between its wake and sleep states or that movement has occurred. We are only interested in the wake-to-sleep transition, so when the interrupt occurs the micro interrogates the accelerometer to find the source of the interrupt.

If the accelerometer has gone to sleep, the firmware turns off the display and puts the microcontroller to sleep too, configuring it to wake up only when a new interrupt occurs on pin 17. This happens only when there is further movement which re-awakens the accelerometer.

The final interrupt service routine is invoked when the user presses and releases the calibration button (S1). This routine zeroes the display and stores the current angle as the offset value in the micro's internal EEPROM memory. This allows you to compensate for any imperfection in the alignment of the mechanical axes of the accelerometer relative to the case. It's unlikely that the accelerometer IC is perfectly aligned with the metal case (due to both misalignment between the IC and PCB, and the PCB and the case) but this can be compensated for

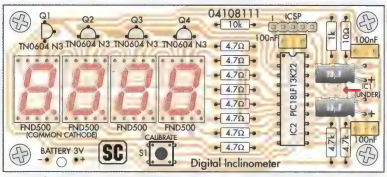


Fig.3: install the parts on the PCB as shown on this layout diagram. Note that the two 10uF capacitors must be mounted on their sides.

This prototype differs slightly from the final version shown in Fig.3 (eg, Q1 is orientated differently and hole for the battery leads has been moved.

to give a zero reading on a perfectly level surface.

Power consumption

In sleep mode, the micro draws less than 100nA and the accelerometer only 14μA – amazing considering it is still measuring acceleration and checking for movement. In use, the inclinometer draws around 50mA, most of which is consumed by the display. With moderate usage therefore, the two 1.5V AA batteries should last many months.

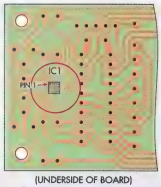
The inclinometer monitors the battery voltage and when it falls to around 2.85V, lights one decimal point on the display to indicate that the battery is low. Since every pin on the micro is used, we had to resort to a clever trick to monitor the battery.

The microcontroller's ADC is configured to measure a fixed internal 1.024V band-gap voltage using the supply voltage as the reference. This is the opposite of the way we would normally do things and means that as the battery voltage falls, this measurement actually increases. It's not a linear relationship but it is more than adequate for detecting a low battery level.

Construction

The Digital Inclinometer is built on a small, single-sided PCB. All components are through-hole types with the exception of the accelerometer (IC1) which is in a tiny 16-pin QFN (surface-mount) package. This is the first thing you should fit. It takes some patience and a steady hand but it can be soldered in manually.

First, carefully tin the pads. You want a thin, even layer of solder, so use solder wick to clean up any bumps or shorts between pads. Check carefully for solder shorts between pads at this point and fix them now. Once the chip is down, you will not be able to see the joints.



(UNDERSIDE OF BOARD)

Fig.4: the MMA8451Q is mounted on the copper side of the PCB as shown here.

Left: a close-up view of the MMA-8451Q in position. Be sure to orientate it correctly.

Now carefully place the accelerometer on the pads, lining up the tiny dot on its body with the corresponding dot on the PCB layout. In addition, make sure that the chip is properly lined up with the pads on all four sides. The small marks on the sides of the chip indicate the pin positions and these must be perfectly lined up with their corresponding pads.

Once it's fully lined up, you need to melt the solder under each pad, without moving anything. If you have a hot-air rework station, you can use this to gently heat the chip until the solder reflows. If you don't, you need to use a soldering iron to apply heat to each pad in turn, all the while holding the chip in place. The idea is to melt that thin layer of solder you applied to the pads and to heat the corresponding contact on the chip so that the two

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	8	4.7Ω	yellow violet gold brown	yellow violet black silver brown

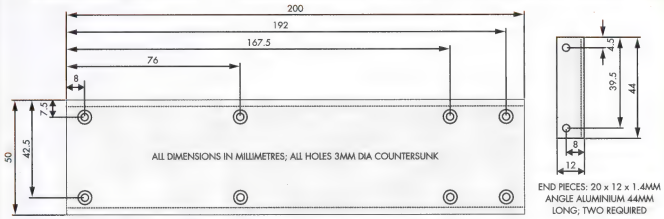


Fig.5: the base is made from a 200mm length of 50 x 25 x 3mm aluminium channel, while the two end pieces (right) are made from 44mm lengths of 20 x 12 x 1.4mm aluminium angle extrusion.

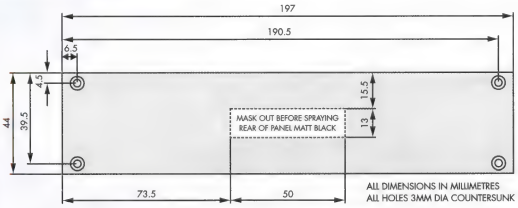


Fig.6: the front panel is made from 3mm red Perspex. Drill and countersink carefully as the material fractures easily. The back of the panel is sprayed matte black, except for the display window shown dotted.

Left: this is the view inside the case before the PCB and battery are installed. The end pieces are secured using M3 x 6mm countersink-head screws and M3 x 16mm tapped metal spacers. The Perspex front panel (below) is spray-painted matte black on the inside, with the display window masked out.

The PCB is mounted inside the case on four M3 x 6mm spacers and secured using machine screws (pan head on top, countersink head through the case).

bond. Take your time, but try not to overheat the accelerometer.

Now use a multimeter to check for any unintentional shorts between adjacent pads. If there is a solder short between two adjacent pins, you will be able to remove it using solder wick.

Once the accelerometer (IC1) is in position, the remaining parts can be installed in order of height, ie, from lowest to highest. Note that the Mosfets (Q1-Q4) have to be pushed down so that they do not stand proud of the 7-segment displays. Likewise, the two electrolytic capacitors are mounted on their sides (ie, with their leads bent down at right angles), so that they are lower than the display faces.

The 7-segment displays are soldered directly to the PCB. Make sure that they sit flush with the board surface and that they are orientated correctly (ie, each decimal point at lower right).

Having completed the board assembly, attach the battery holder and insert a pair of fresh AA cells. If everything is working correctly, the display will show four dashes while the PCB is face up.

Now slowly tilt the board up to vertical with its long edge on the bench and check that it displays an angle within a few degrees of horizontal (ie, just above 0.0 or just below 360.0). If that checks out, hold it perfectly still for about 30 seconds. At the end of this period, the display should go blank as the device falls asleep. When it does, give it a firm shake to wake it up again.

Finally, check the calibration button by positioning the board at an angle of a few degrees and briefly pressing the calibration button. When the button is released, the display should read zero.

Troubleshooting

If there is no display, check that the component values and orientations are correct. That done, visually inspect the solder side for bad joints or solder shorts. If that looks OK, use a multimeter to check for 3V on the micro's supply pins (ie, between pins 2 & 20) and check that the MCLR pin is pulled high. If you have access to a scope or frequency counter, check for 5ms pulses repeated every 20ms at the gates of the Mosfets. If these are present, you can be confident the micro is operating.

If the micro is working but no angle measurement takes place, the problem probably lies with the soldering of the accelerometer. In that case, remove the batteries and inspect your work with the aid of a magnifying glass. Since you checked for shorts earlier, the most likely problem is an open-circuit pin so carefully resolder each one using a fine-tipped iron and applying very small amounts of solder.

Basically, you want the solder to melt and wick up under the chip. If you inadvertently apply too much solder, use solder braid to remove the excess.

Housing

We made the housing from a length of 50 x 25 x 3mm aluminium channel (a standard extrusion that should be available from your local aluminium centre). The end pieces are also aluminium extrusions, this time 20 x 12 x 1.4mm angle extrusion.

You will have to cut and drill the aluminium as shown in Fig.5, taking care to de-burr all the holes. If you want a form factor more akin to a spirit level, you can cut the 50mm channel longer than shown, so that it extends out either side of the end-pieces.

The front panel is a piece of trans-

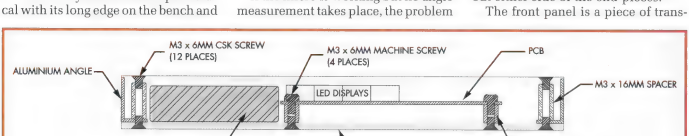
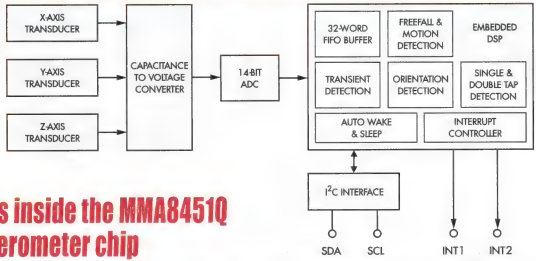


Fig.7: this cross-section diagram shows how the Inclinometer is assembled into its case. The battery holder is held in place with foam-core double-sided tape.



What's inside the MMA8451Q accelerometer chip

The Freescale Semiconductor MMA8451Q is a 14-bit 3-axis accelerometer with a built-in DSP (Digital Signal Processor) and a plethora of embedded functions. The acceleration transducers are MEMS (Micro Electromechanical Systems) technology which combines on-chip nano-scale mechanical parts with electronic components.

In this case, each transducer is a microscopic sprung mass which forms the moving plate of a capacitor. As the mass moves against the spring, under the influence of acceleration, the capacitance changes. The capacitance is converted to a voltage and then digitised by the 14-bit ADC for processing by the on-board DSP.

The gain can be configured for full-scale readings of ±2g, ±4g or ±8g and the transducers are sampled at a programmable rate of up to 800 times per second. Naturally, faster sampling increases power consumption.

Although the ADC has 14-bit resolution, the effective resolution of the device is limited by mechanical and electronic noise. The signal-to-noise ratio (SNR) can be improved by oversampling, where multiple samples are averaged into each reading. Many combinations of sampling rate and oversampling are available, allowing the user to trade off accuracy, update rate and power consumption.

The sampled data is available for direct readout via the I^2C bus but some of the real power of this device comes with the embedded DSP functions. The chip is extremely flexible, if a little difficult to master, with a 50-page datasheet and more than 40 configuration registers.

For example, the output data may be directed to a FIFO (first in, first out) buffer capable of storing up to 32 samples. This means that at high sample rates, the microcontroller can wait until several samples have accumulated before reading them all in one go. The FIFO can even be read out while simultaneously capturing data.

A freefall/motion detector can detect when the device is falling. This is often used in portable devices to park the hard disk drive read heads safely before impact. Alternatively, this functional block can be configured to detect motion. The user can configure both the level and duration of movement required to qualify as valid motion, configure a high-pass filter and nominate which axes are to be monitored.

Orientation function

An orientation function detects whether the accelerometer is oriented in "portrait" or "landscape" mode, whether it is face up or face down and whether it's upright or upside-down. The transition points and the hysteresis between them are configurable.

The transient function detects fleeting events such as flicks and shakes. This makes use of a configurable high-pass filter and configurable level and duration thresholds. Another block can detect single and double-tap events and can determine on which axis and in which direction the tap originates. Once again the amplitudes, durations and delays are all programmable via the I^2C interface.

Most of these functions can be selected as inputs to the auto sleep/wake function, which either puts the device into a sleep mode or wakes it up. The device is still active in sleep mode; it just falls back to a (programmable) lower sampling mode and rate. Current consumption can be as low as 6μA in this state, even though the chip is fully functional. There is also a standby mode.

The MMA8451Q also contains an interrupt controller. The interrupt sources include all the functional blocks, the availability of new data and the sleep/wake logic. Any source can be directed to either of the two outputs and the outputs can be configured for polarity. You can even select whether the outputs are push-pull or open drain!

lucent red Perspex, cut and drilled according to Fig.6. Keep the protective film in place as long as possible to avoid scratches. The inside of the Perspex is spray-painted matte black after masking off the rectangular section that will be directly in front of the LED displays (see above photo).

The best way to make this mask is to first peel off the protective film on the inside surface and then cover the central section (ie, where the display window goes) with masking tape. Make sure you slightly overlap each strip so that there are no gaps.

That done carefully measure and draw the rectangular window onto the tape. You can now use a sharp hobby knife and a metal straight-edge to cut through the tape around the window. Don't press too hard – you want to

The completed Inclinometer is shown here, together with a conventional spirit level at the rear. The unit measures in 0.1° steps from 0-360° (the resting surface here is not quite level).

cut through the tape but not score the Perspex too deeply. Finally, you can peel off the excess tape, leaving just a neat rectangle in the middle, ready for spraying.

Fig.7 shows how the whole thing goes together. The end pieces are each held in place by two M3 x 16mm spacers which are secured using M3 x 6mm countersunk machine screws. These spacers also support the front panel. The PCB is supported on four M3 x 8mm spacers and these are also secured to the case using M3 x 6mm countersunk machine screws.

It's best to test-fit the whole assembly, then use some Loctite to secure the eight countersunk screws holding the spacers into the housing.

You can now paint the case to your liking, ensuring you don't get paint in the threads of the spacers. Once that's done, add some foam-core double-sided tape inside the case to hold the battery in place (see photo) and secure the PCB using four M3 x 6mm pan head screws.

Calibration

To calibrate the unit, place it on a known level surface (a 2-metre spirit level will typically be accurate to 0.05°) and press the calibrate switch. Alternatively, you could level a piece of timber or metal using a water level made from clear plastic tubing.

Pressing switch S1 now automatically calibrates the unit. You can confirm that it is correct by checking that the unit indicates 0° when it is orientated in either direction.

The unit can then be completed by fitting the Perspex front panel and securing it using four M3 x 6mm countersunk machine screws.

That's it! Your new Inclinometer is now ready for use. It's a simple project that nicely demonstrates the power and versatility of MEMS devices. **SC**

Parts List

1 PCB, code 04108111, 100 x 44mm
1 tactile pushbutton momentary switch (S1) (Jaycar SP0601, Altronics S1120)
1 5-way pin header (ICSP) (2.54mm pitch)
1 2 x AA battery holder (Jaycar PH9202)
1 200mm-length of 50 x 25 x 3mm aluminium extrusion
2 44mm lengths of 20 x 12 x 1.4mm aluminium angle extrusion
1 red Perspex sheet, 197 x 44 x 3mm
4 M3 x 16mm tapped spacers
4 M3 x 8mm tapped spacers
12 M3 x 6mm countersunk machine screws
4 M3 x 6mm pan head machine screws
1 330 x 20 x 3mm length of closed-cell foam
1 180mm length of regular double-sided tape
1 60mm length of foam-core double-sided tape
masking tape
black & yellow paint

Semiconductors
1 MMA8451Q 3-axis accelerometer (IC1) (Mouser*, Digikey, Element14 Order Code 1842359)
1 PIC18LF14K22-I/P microcontroller programmed with 0410811A.hex (IC2) (Mouser*, Digikey, Element14 Order Code 1770702)
4 TN0604N3 Mosfets (Q1-Q4) (Mouser* 689-TN0604N3-G)
4 FND500 7-segment LED displays or equivalent (Jaycar ZD1855, Altronics Z0190)

** Mouser components are available either direct from Mouser or via Active Components in Australia & NZ.*

Capacitors
2 10µF 16V electrolytic
3 100nF MKT or monolithic ceramic

Resistors (0.25W, 1%)

1 10kΩ	1 10Ω
2 4.7kΩ	8 4.7Ω
1 1kΩ	

SILICON CHIP REFERENCE BOOKSHOP

NEW NEW NEW NEW

PROGRAMMING and CUSTOMIZING THE PICAXE By David Lincoln (2nd Ed, 2011)

A great aid when wrestling with applications for the popular PICAXE series of microcontrollers. Works at beginner, intermediate and advanced levels. Every electronics class, school and library should have a copy, along with anyone who works with PICAXEs. ***See the review in April 2011 SILICON CHIP.***
300 pages in paperback

$65

PROGRAMMING 32-bit MICROCONTROLLERS IN C By Luci di Jasio (2008)

Subtitled Exploring the PIC32, a Microchip insider tells all on the newest, most powerful PIC ever! Condenses typical introductory "fluff" focusing instead on examples and exercises that show how to solve common, real-world design problems quickly. Includes handy checklists.
FREE CD-ROM includes source code in C, the Microchip C30 compiler, and MPLAB SIM.
400 pages paperback. ~~$84.90~~

$79

NEW LOW PRICE!

PIC IN PRACTICE by D W Smith. 2nd Edition - published 2006

Based on popular short courses on the PIC, for professionals, students and teachers. Can be used at a variety of levels. An ideal introduction to the world of microcontrollers. 255 pages in paperback.

$60

NEW LOW PRICE!

PIC MICROCONTROLLERS: know it all Multiple authors

The best of subjects Newnes authors have written over the past few years, combined in a one-stop maxi reference. Covers introduction to PICs and their programming in Assembly, PICBASIC, MBASIC & C. More than 900 pages in paperback. ~~$99.00~~

$83

PIC MICROCONTROLLER –YOUR PERSONAL INTRODUCTORY COURSE By John Morton 3rd edition 2005.

A unique and practical guide to getting up and running with the PIC. It assumes no knowledge of microcontrollers – ideal introduction for students, teachers, technicians and electronics enthusiasts. Revised 3rd edition focuses entirely on re-programmable flash PICs such as 16F54, 16F84 12F508 and 12F675. 226 pages in paperback.

$60

USING UBUNTU LINUX by J Rolfe & A Edney – published 2007

Ubuntu Linux is a free and easy-to-use operating system, a viable alternative to Windows and Mac OS. Introduces Ubuntu, tells how to set it up, covers the various Open Office applications and gives troubleshooting hints and tips. Highly recommended.
222 pages in paperback

$27

SOLAR SUCCESS – Getting it right every time by Collyn Rivers. 1st edition

The complete guide to home and property systems. Covers the ramifications of lighting, fridges and freezers, air conditioning, washing machines and driers and much more on solar systems; also covers solar basics and how to conduct an energy audit. As reviewed in SILICON CHIP November 2008. 112 pages.

$47.50

SMALL SIGNAL AUDIO DESIGN By Douglas Self – First Edition 2010

The latest from the Guru of audio. Explains audio concepts in easy-to-understand language with plenty of examples and reasoning. Inspiration for audio designers, superb background for audio enthusiasts and especially where it comes to component peculiarities and limitations. 558 pages in paperback
Expensive? Yes. Value for money? YES! Highly recommended. ~~$132.95~~

$88

NEW LOW PRICE!

TV ACROSS AUSTRALIA Edited by Kaz Bielecki – 4th Edition 2007

The Grey Army's "Bible"! Travelling around Australia? Want to know where to point the antenna? This has the channels, polarity and location of all analog television transmitters and translators from coast to coast. (Any digital TV services are usually co-sited). Plus coverage maps, analog tv transmitter data . . . for the first time, everything you need to know in the one place!
NOW REDUCED! ~~$89.95~~

$39

PRACTICAL GUIDE TO SATELLITE TV By Garry Cratt – Latest (7th) Edition 2008

Written in Australia, for Australian conditions by one of Australia's foremost satellite TV experts. If there is anything you wanted to know about setting up a satellite TV system, (including what you can't do!) it's sure to be covered in this 176-page paperback book.

$49

NEWNES GUIDE TO TV & VIDEO TECHNOLOGY By KF Ibrahim 4th Edition (Published 2007)

It's back! Now in a new edition provides a full and comprehensive coverage of video and television technology including HDTV and DVD. Starts with fundamentals so is ideal for students but covers in-depth technologies such as Blu-ray, DLP, Digital TV, etc so is also perfect for engineers. 600+ pages in paperback. ~~$58.00~~

$49

NEW LOW PRICE!

RF CIRCUIT DESIGN by Chris Bowick, Second Edition, 2008.

A new edition of the classic RF circuit design book. RF circuit design is now more important that ever in the wireless world in which we live. In most of the wireless devices that we use there is an RF component – this book tells how to design and integrate in a very practical fashion. 244 pages in paperback. ~~$73.00~~

$63

NEW LOW PRICE!

OP AMPS FOR EVERYONE NEW 3RD EDITION!

By Carter & Mancini. Substantially updates coverage for low-speed and high-speed applications, and provides step-by-step walk-throughs for design and selection of op amps. Huge 648 pages! ~~$130.00~~

$100

SOLAR THAT REALLY WORKS – Motorhomes, 5th Wheelers, Campervans, Cabins by Collyn Rivers. 2nd edition

All the information you need for successful solar installation in mobiles.An expert on getting the most out of solar systems, Collyn Rivers dispels many of the myths and helps you get it right when there is no mains power available.

$42.50

10% OFF!

WANT TO SAVE 10%? SILICON CHIP (PRINT EDITION) SUBSCRIBERS* AUTOMATICALLY QUALIFY FOR A 10% DISCOUNT ON ALL BOOK PURCHASES!

(*Does not apply to website orders)

See the handy order form elsewhere in this issue!

WOW! WHAT AN OFFER!

SILICON CHIP'S PERFORMANCE ELECTRONICS FOR CARS AND SILICON CHIP'S ELECTRONIC PROJECTS FOR CARS Vol 2 – BOTH BOOKS TOGETHER AT A VERY SPECIAL PRICE!

Here's sensational value: **PERFORMANCE ELECTRONICS FOR CARS** (was $19.80) and **ELECTRONIC PROJECTS FOR CARS VOL 2** (Originally $12.95) at a huge saving. While stocks last (they're getting low) and some might be slightly shop soiled – but just look at the saving! Get more performance, more projects for your car and SAVE!

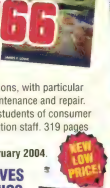
$15.00

AC MACHINES

by Jim Lowe Published 2006

Applicable to Australian trades-level courses including NE10 AC Machines, NE12 Synchronous Machines and the AC part of NE30 Electric Motor Control and Protection.

Covering polyphase induction motors, single-phase motors, synchronous machines and polyphase motor starting. 160 pages in paperback.



$66

See Review March 2010

NEW LOW PRICE!

AUDIO POWER AMPLIFIER DESIGN HANDBOOK

by Douglas Self **NEW 5th Edition 2009**

The latest edition of "the Bible" on audio power amplifiers. Many revisions and updates to the previous edition and now has an extra three chapters covering Class XD, Power Amp Input Systems and Input Processing and Auxiliarly Subsystems. Not cheap and not a book for the beginner but if you want the best reference on Audio Power Amps, you want this one!

463 pages in paperback. ~~$174.00~~

$81

NEW LOW PRICE!

$71

NEW LOW PRICE!

DVD PLAYERS AND DRIVES

by K.F. Ibrahim. Published 2003.

A guide to DVD technology and applications, with particular focus on design issues and pitfalls, maintenance and repair.

Ideal for engineers, technicians, students of consumer electronics and sales and installation staff. 319 pages in paperback. ~~$82.50~~

As reviewed in Silicon Chip February 2004.

SELF ON AUDIO

by Douglas Self 2nd Edition 2006

A collection of 35 classic magazine articles offering a dependable methodology for designing audio power amplifiers in a way that improves performance at every point without significantly increasing cost. Includes compressors/limiters, hybrid bipolar/FET amps, electronic switching and more. 474 pages in paperback. ~~$89.00~~

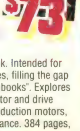
$69

NEW LOW PRICE!

PRACTICAL VARIABLE SPEED DRIVES AND POWER ELECTRONICS

by Malcolm Barnes. 1st Ed, Feb 2003.

An essential reference for engineers and anyone who wishes to design or use variable speed drives for induction motors. As reviewed in Silicon Chip September 2003. 288 pages. ~~$99.00~~



$73

NEW LOW PRICE!

$61

NEW LOW PRICE!

PRACTICAL RF HANDBOOK

by Ian Hickman. 4th edition 2006

The latest guide to RF design for engineers, technicians, students and enthusiasts. Covers key topics in RF: analog design principles, transmission lines, couplers, transformers, amplifiers, oscillators, modulation, transmitters and receivers, propagation & antennas. 279 pages in paperback. ~~$79.00~~

$51

ELECTRIC MOTORS AND DRIVES

By Austin Hughes - Third edition 2006

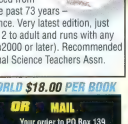
Brand new edition of this amazingly popular book. Intended for non-specialist users of electric motors and drives, filling the gap between academic texts and general "handbooks". Explores all of the widely-used modern types of motor and drive including conventional & brushless DC, induction motors, steppers, servos, synchronous and reluctance. 384 pages, soft cover. ~~$59.00~~

$40

BUILD YOUR OWN ELECTRIC MOTORCYCLE

by Carl Vogel. Published 2009.

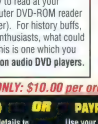
Alternative fuel expert Carl Vogel gives you a hands-on guide with the latest technical information and easy-to-follow instructions for building a two-wheeled electric vehicle – from a streamlined scooter to a full-sized motorcycle. 384 pages in soft cover. ~~$79.95~~



SWITCHING POWER SUPPLIES A to Z

by Sanjaya Maniktala. Published 2006.

Theoretical and practical aspects of controlling and measuring electromagnetic interference in switching power supplies. Includes flow-charts for building DC-DC converters and their magnetic components under typical wide-input supply conditions. 503 pages in hard cover. ~~$100.00~~



$91

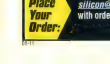
NEW LOW PRICE!

CD-ROM included.

RADIO, TV AND HOBBIES April 1939 to March 1965

– Every article to enjoy once again on DVD-ROM!

This remarkable archival collection spans nearly three decades of Australia's own "Radio and Hobbies"/"Radio TV and Hobbies". Every article has been scanned into PDF format – ready to read at your leisure on your computer (obviously, a computer DVD-ROM reader is required along with Acrobat Reader 6 or later). For history buffs, it's worth its weight in gold. For vintage radio enthusiasts, who could be better? For anyone interested in electronics, this is one which you *MUST* have in your collection! **NB: Does not play on audio DVD players.**

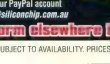


$62

THE AMATEUR SCIENTIST CD

Brand new V4.

Many thousands of copies now sold. An incredible CD containing over 1000 classic projects, sourced from Scientific American over the past 73 years – covering every field of science. Very latest edition, just out. Suits ages 12 to adult and runs with any browser (on Win2000 or later). Recommended by the US National Science Teachers Assn.



$62

NOTE: ALL PRICES ARE PLUS P&P – *AUSTRALIA ONLY: $10.00 per order; NZ – $12.00 PER BOOK; REST OF WORLD $18.00 PER BOOK*

To Place Your Order:	eMAIL (24/7)	OR	FAX (24/7)	OR	PAYPAL (24/7)	OR	PHONE - (9-5, Mon-Fri)	OR	MAIL
	silicon@siliconchip.com.au with order & credit card details		Your order and card details to (02) 9939 2648 with all details		Use your PayPal account silicon@siliconchip.com.au		Call (02) 9939 3295 with your credit card details		Your order to PO Box 139 Collaroy NSW 2097

Or, use the handy order form elsewhere in this issue

*ALL TITLES SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES INCLUDE GST

SERVICEMAN'S LOG

Who pays when it dies on the bench?

It happens – one minute you are happily working away on a repair and the next minute it dies on the bench. It's one of those wretched moments all service people dread and it's not unknown for customers to try to take advantage of the situation.

Items Covered This Month

- When it dies on the bench
- Warranty claims
- Vectrix electric bike battery repair

Most computers arriving at our workshop are ailing but not terminal. And while we do get machines that are dead on arrival, these were relatively few and far between before the quakes. Even after the quakes, most machines are still working to some extent although often not very well.

The big question when a machine dies on the bench is "why?". If the hardware was failing anyway and it just picked this moment to completely curl up its toes, then it's just bad luck. However, if a technician drops something onto the motherboard while the machine is running and there is a flash accompanied by a puff of expensive-looking smoke, that's a completely different story.

Either way, it raises the unpleasant task of calling the customer to inform them of what happened. If they were aware that things were dire before they brought the computer in then it's usually no problem. However, it's a different matter if the machine was in for, say, virus removal and now the customer gets a call telling them their computer has completely "died" on the bench.

Naturally, this all leads onto another big question: who pays for it? This can turn an already unpleasant situation into a rather ugly one. If it is just bad luck, then the client is expected to take the lumps. If the technician killed it, then the company has to foot the bill.

~ ONE MINUTE YOU ARE HAPPILY WORKING AWAY ON A REPAIR AND THE NEXT MINUTE IT DIES ON THE BENCH

If the thing has died for no apparent reason (the bad luck gambit), it can be quite a challenge getting the client to accept that they'll have to shell out to replace whatever has failed. Just how things go in that situation often depends on your relationship with the client. Some will shrug their shoulders and accept it as a fact of life while others will kick up a stink and want to make a mountain out of molehill. Occasionally, things can turn nasty very quickly, with all manner of threats bandied about.

Of course, if the machine was already "iffy" (we always boot the machine in front of the client during book-in), the client is usually OK. After all, they probably half-expected to be told this anyway.

The worst-case scenario when it comes to having hardware die on the bench is a client's hard drive which has not been backed up. This is always gutting as the client often cannot understand why the drive would fail "just like that". Of course, hard drives can suddenly fail but there are not too many explanations we can give that are easily understandable by the average punter.

It's even worse if the serviceman has dropped the drive or has done something silly and killed it. But however a drive dies, it usually has tragic consequences as backing up seems to be the last thing computer users think about. I have had adults literally crying in our reception area when I have had to break the bad news that their data has gone forever.

Items like video of baby's first steps, irreplaceable photos and other

data can possibly be recovered by a dedicated data-recovery company but this is out of financial reach for most people. Fortunately, we have not yet killed a hard drive by being negligent (touching wood). In all cases, any data loss has occurred before the drives were brought in, which is why our help was sought in the first place. However, even the thought of losing a client's data makes me shudder.

If one does make a mistake, it's often very difficult to put one's hand up and admit it. Not only does this put the fault firmly in the serviceman's lap but it also means replacing dead hardware at our own cost. However, telling bald-faced lies about what has happened isn't very smart or professional either and unless the serviceman is an accomplished fibber, clients tend to know when they are being conned.

Communication is the key and almost any dire situation can be resolved by talking things out. If the client is reasonable and fair, so much the better but there are always those who prefer to jump on the bandwagon to extract as much as they can.

Some time ago, we had a rather nasty experience with a client who brought in a notebook that had been having screen flickering problems. We'd already repaired it under warranty and when he brought it in again claiming the same problem we stupidly took his word for it. Instead of firing it up on the reception bench in front of him, as is our usual practice, we simply "shelved it" and got on with other jobs.

When we got to it, it wouldn't boot at all. Upon removal of the keyboard, we noted a liquid spill; coffee by the smell of it. We called the client and he said yes, coffee had been spilled on it but not enough in his opinion to cause it to stop working.

I immediately told him that it was almost certain that it was the coffee that had killed the laptop but he didn't want to listen. Long story short – he took it to arbitration and won by claiming that it was us who must have caused the spill.

Sometimes you can't win, even when justice dictates you should.

Warranty claims

It's a fact of life that, on occasions, something we installed, sold, repaired or otherwise handled will be returned under warranty. If the item is new, chances are the manufacturer will cover it provided that it's a genuine failure and not due to customer negligence. Most hardware usually sports at least a 12-month RTB (return-to-base) warranty. If a problem arises, the buyer returns the item to the seller who typically handles things from there.

Those new to business often overlook warranty considerations when pricing their services. But it's a vital consideration. In this line of work, you have to factor in the possibility that, even years down the track, you might be expected to sort out repairing or replacing goods under warranty. This sometimes takes considerable time and depending on circumstances, the client usually expects it to be done free of charge.

In most cases, service people honour warranties without hesitation because future business depends on it. Any vendor who rips off a client and doesn't stand firmly behind what they sell is both foolish and unprofessional. It also annoys me when I see hardware such as certain hard drives, which I know come with a 3-year factory warranty, being sold with a "standard" 1-year warranty. The "generous" retailer then offers to "add two more years of extended cover for just X dollars more".

I see this type of rort all too often and in my opinion, the perpetrators should be put in stocks and pelted with rotten

vegetables in the town square. In my shop, if something has a specific factory warranty, that warranty is passed directly on to our clients without any additional cost or conditions. In fact, from a marketing perspective it is an excellent selling point.

If we sell and stand behind our products, our expectation is that manufacturers will do the same, without contriving to avoid their warranty obligations and responsibilities. After all, what is one replacement unit to a multi-billion dollar company?

Well, after that little spray, you would be entitled to think that it was all leading up to something. And you'd be right. The following happened recently to one of my staff who purchased a 24-inch LCD monitor from our company at a special sale price.

This particular monitor is a high-quality unit aimed at the upper end of the market, as evidenced by a 3-year zero-dead-pixel warranty. My employee duly took delivery and was more than happy with its performance and overall quality, especially considering the special "sale" price he paid for it.

Unfortunately, his satisfaction evaporated after just a few weeks when he noticed that the image had started to shimmer slightly and intermittently took on a slight discoloured tinge. He carried out the usual troubleshooting procedures we use when dealing with such symptoms and confirmed that it was the monitor itself that was at fault (not the computer).

A call to the manufacturer's toll-free number soon had a job raised and a courier assigned to pick it up. This seemed like excellent service until a week went by with no sign of the man and his van. Another call to the company revealed that the job had not been entered into the system properly and the call ended with an apology and a promise they'd have a van out the very same day. They were close; it arrived the following afternoon.

Like some other companies, this crowd wanted returned items to be in their original packaging. No problem; my employee had saved everything and had bundled the monitor up just like new, with the unit tucked nicely into its original bag and polystyrene "end-caps". He also included all the leads that originally came with it.

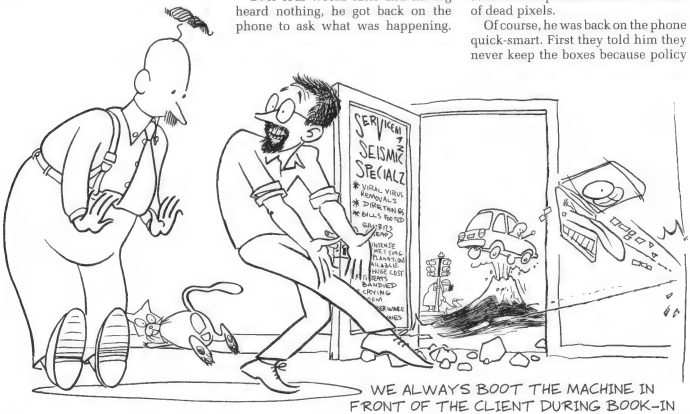
Over four weeks later and having heard nothing, he got back on the phone to ask what was happening. This company usually turned their laptops and peripheral repairs around pretty smartly, so this was out of the ordinary. Their answer was that they were waiting for parts and they promised that as soon as they arrived, the monitor would be repaired and returned.

Six weeks and two days after it had been picked up, a large package turned up. Gone was the original packaging; instead the monitor had been shipped already mounted on its removable base and positioned diagonally across the box, with large balls of bubble-wrap squashed in either side to hold it upright.

To add insult to injury, there was no sign of the cables and I have to say that neither of us was impressed.

Unfortunately, that was the least of my employee's problems. The replacement unit was obviously not the same monitor. It wasn't even the same model but one date-stamped a full year and a few model numbers before the one he sent away. And while, on paper, the specifications were close enough for anyone but the most pedantic, what really annoyed him was that the replacement looked like it had been through the wars, with marks and scratches all over the case. On top of that, when tested, it not only had several dead pixels but several blocks of dead pixels.

Of course, he was back on the phone quick-smart. First they told him they never keep the boxes because policy



demands they be recycled. They then claimed that he was better off because the replacement unit was a better monitor, though the same dead-pixel warranty didn't apply, so he would have to put up with a certain number of dead pixels before triggering the warranty.

Determined not to put up with any more of their nonsense, he bluntly told them that this was totally unacceptable. And he demanded that they replace the original monitor with one that was the same (or better) than the original and which had zero dead pixels.

A few days later, a brand new monitor arrived and we both marvelled at why they just didn't do that in the first place.

In situations like this, it is the reseller who suffers, not the repair agent, and I couldn't imagine having to go through all this palaver with a valued client. I had expected far better from this company and now think twice about recommending their products.

Vectrix battery repair

Back in the June 2009 issue, we described an electric ute conversion by Malcolm Faed. That's just the sort of background you need for repairing an electric bike. Here's Malcolm's story . . .

I was contacted through the SILICON CHIP office to see if I could assist with a battery fault in a Vectrix motorcycle (**http://vectrix.com.au/**). The owner's complaint was that the bike had poor performance due to a faulty cell and was stopping after just a few kilometres.

After some thought, we were eventually able to remove the covers and expose the battery pack. This consisted of 102 cells arranged in two blocks. The rear block is nine cells long, two wide and three deep, giving a total of 54 cells. Similarly, the front block is eight long, two wide and three deep for a total of 48 cells.

Each set of cells is bound by a steel compression band to prevent them from expanding when heated during charging and discharging. The layers are fitted in a plastic frame and are held together by long threaded rods extending between the rows and also by duct tape around the outside of the frames.

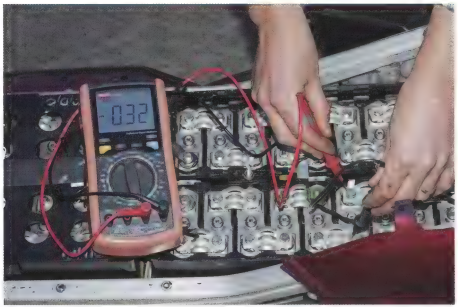
The top of the rear block was removed and some evidence of corrosion was visible on one of the cells. This particular cell had also overheated and the plastic frame it sits on had melted. In addition, the pressure relief valve on the top of the cell had released, causing some corrosion and crystallisation of electrolyte around the top of the cell.

We also verified that the cell had failed electrically. It measured just 32mV while the others were consistently at about 1.31V. From that, we surmised that there was only one dead cell in the pack as the other strings of cells had a near perfect multiple of 1.31V across them.

The cells in the Vectrix are 30Ah NiMH (nickel metal hydride) types from GP Battery and replacements are available from the distributor in Melbourne – see cell data sheet: **http://www.gpina.com/pdf/GP30EVH_DS.pdf**

Having established the fault, we decided to disassemble the entire pack, measure each cell voltage and check for evidence of more failing or faulty cells. The first thing to do was to disconnect the large blue Anderson connector on top of the batteries. This breaks the battery pack up into safer, lower-voltage blocks.

Wagner
Visit Us Online: www.wagner.net.au
Email: sales@wagner.net.au
Phone: 02 9736 9233 Fax: 02 9736 0017
Address: 138 Liverpool Road, Ashfield, NSW, 2131



The faulty cell in the battery pack had visible corrosion on its case and had overheated and partially melted the plastic frame it sits in. It measured just 32mV while the rest were at about 1.31V.

This close-up view shows the temperature sensor boards for the rear battery pack.

The temperature and voltage sense boards were also disconnected at the connectors at the front and rear of the bike. Basically, there are temperature and voltage sensing elements screwed to some of the battery terminals. These were numbered with a marker on each sense board and also on the cells they were removed from to ensure they were replaced in the correct locations. Each sense board was then wrapped in insulation tape as it was removed, to prevent it from accidentally touching the battery terminals.

All the other cells were at the correct voltage (~1.3V). However, two adjacent cells to the faulty cell had suffered heat damage and as stated above, the plastic holders had also melted. As a result, three new cells and plastic frame pieces were ordered from the Australian agent.

When introducing new cells into a battery pack, it is important that they be in the same charge state as the existing cells. To ensure this, I initially used a charger for radio control models to charge the three replacement cells. This charger also has a discharge function, so I was able to then discharge the cells down to the same voltage as the existing good cells.

In operation, the charger can charge at 10A and discharge at 1A, while the cell chemistry, charge current, end-point sensitivity etc can all be programmed into the unit. NiMH cells self-discharge quite quickly. In the end, I got the final voltage of the new cells to within about 10mV of the existing cells. The first balance charge on the bike would then balance them further.

Having charged the cells, the next step was to replace them. Removing the steel strap was easy enough (it's just a matter of unfolding the locating tabs) but replacing it is another matter. After doing plenty of internet research, I found the best way to reassemble the nine cells under compression was to use long stainless steel hose clamps to secure and compress the cells when refitting the steel band.

The battery pack in the Vectrix is made up of 102 cells arranged in two separate blocks – 48 in the front block and 54 in the rear. Each cell measures 1.31V for a total output of about 134V.

To make things even trickier, the brittle locating tabs had snapped off the steel band. These tabs were replaced by feeding steel wire through the holes in the strap. The wire was then tensioned by twisting it and then folding it over, after which the hose clamps were removed. The sharp edges of the wire fastening were then folded inward and covered with duct tape to prevent abrasion.

Reassembling the battery pack is basically the reverse of the disassembly process. Extra care was taken to double-check (both visually and with a voltmeter) that each nine/eight cell bank was reassembled correctly and that the temperature and battery voltage monitoring sensors were installed in the correct locations. After reassembly, all interconnects and battery terminals that had been removed were tightened as specified to a torque of 10Nm.

With the job completed, the owner took the bike for a ride and came back with a big grin. It had performed better than it had for a long time.

The final task for the owner is to deep discharge the pack five times to condition the batteries and ensure longevity of the new batteries. This procedure is recommended by Vectrix to remove any "memory" effect in the batteries, so that they provide their maximum usable capacity. SC

August HOT Deals

August 2011

NETWORK DVR WITH 10" MONITOR AND COLOUR CAMERA KIT 320GB

NEW 2011

This surveillance package offers exceptional value for money. It includes a H.264 DVR with built-in 10" LCD monitor and 320GB HDD, 2 indoor/outdoor colour CMOS 350TVL cameras with IR illumination for night viewing, 2 x 18 cables and power supplies. Everything you need in one box! Recording can be started manually, by programming or by triggered alarm conditions. The main feature is the Smartphone support and the iPhone® app you can download from iTunes® to view live or recorded footage*. Monitoring may be done real-time on a monitor, LAN network, via internet or Smartphone. The DVR functions can be controlled by mouse or the IR remote control.

- Dimensions:
  DVR/Screen: 208(L) x 85(W) x 242(H)mm
  Camera: 115(L) x 45(H)mm

QV-3030

$799.00

HOT DEAL

FREE Extra Camera (QC-3239) valued at $59.95 with every purchase!

*App is free for single use and may incur a charge for multi-user

HOT DEAL

LOOK out for this icon & SAVE!

75 CHANNEL UHF CB HEADSET

Features a 75 channel UHF CB headset, channel scanning, push to talk, VOX and CTCSS. This adjustable headset with plug-in mic provides a high level of passive noise attenuation perfect for a noisy environment such as sporting events, large construction sites etc.

- 0.5W transmission power
- Up to 3km range
- Electronic volume control
- Scan channel, call tone and monitor functions
- Low battery alert
- Adjustable headset with comfort padded ear cups
- Li-ion rechargeable battery and mains charger included

DC-1052

$149.00

NEW 2011

PORTABLE PA SYSTEM WITH MP3 PLAYBACK

A complete PA unit that consists of a 5 channel mixer, MP3 player and DSP effects. It has a pair of amplified 6.5" coaxial speakers pushing out a powerful 70WRMS per channel housed in a tough yet lightweight ABS plastic. Whilst this unit has a truly comprehensive feature list, surely the best is the ability to pack the unit up in one minute courtesy of its special snap lock system.

NEW 2011

Package Includes:

- Main unit: 2 x 70W RMS Amp with 5 channel powered mixer, USB port for MP3 playback and 8 x 24 bit DSP effects
- 48V Phantom power on 3 mixer inputs, RCA record output, high impact ABS main cabinet.
- Rugged dynamic microphone with 4m cable
- Infra-red remote control
- Weight: 14kg
- Dimensions: Overall 550(W) x 310(H) x 215(D)mm

CS-2548

$499.00

NETWORK DVR KIT 500GB WITH 4 IR CAMERAS

Multiplexing DVR system that comes complete with four weatherproof IR outdoor CCD colour cameras and four 20 metre power/video camera connecting cables and power supply. The built-in Ethernet capability enables the unit to be accessed (with password protection) via the Internet using a standard web browser. View live or recorded footage through the Internet or an iPhone®/Smartphone via an app* you can download from iTunes®. The DVR features H.264 compression, advanced motion trigger recording, video loss detection, remote network record and USB back-up support. The system comes fitted with a 500GB HDD.

DVR:

- 4 channel with VGA output & inbuilt multiplexer
- Video format: H.264
- Dimensions: 343(W) x 59(H) x 223(D)mm

Camera:

- Sensor: 1/3" colour CCD
- 420 TV Lines
- Effective range: up to 10m
- Power: 12VDC
- Dimensions: 116(L) x 60(W) x 79(H)mm

QV-8104 WAS $849.00

$699.00 SAVE $150.00

Includes 500GB HDD

HOT

View live or recorded footage on a 3G Smart phone/iPhone

*App is free for single use and may incur a charge for multi-user

NEW PREMIUM RECREATIONAL SOLAR PACKAGES

NEW 2011

Clean renewable energy wherever you go. Solar-convert your 4WD or caravan to generate sufficient power to operate several appliances - including your laptop, portable lighting, CB radio and 12V camping electricals. The included Premium Pulse Width Modulator (PWM) charge controller is feature packed to ensure your battery is efficiently charged and maintained. Just add a battery for your own self-sustained solar powered setup. See website for specifications.

120W Premium Package

1 x 120W monocrystalline solar panel (ZM-9098)
1 x 12V 20A PWM charge controller (MP-3129)
2 x female PV connector (PS-5100)
2 x male PV connector (PP-5102)
ZM-9304

$680.00

160W Premium Package

2 x 80W monocrystalline solar panel (ZM-9097)
1 x 12V 20A PWM charge controller (MP-3129)
3 x female PV connector (PS-5100)
3 x male PV connector (PP-5102)
1 x solar panel Y-lead 2 socket to 1 plug (PS-5110)
1 x solar panel Y-lead 2 plug to 1 socket (PS-5112)
ZM-9303

NEW 2011

$890.00

Also available: **240W Premium Package** ZM-9306 $1260.00

STACKABLE 12V/24V 40A MPPT SOLAR CHARGE CONTROLLER

Maximum power point tracker (MPPT) is an electronic DC to DC converter that optimises the voltage match between your solar panels, battery bank and load. This results in your panels operating at their optimum power output to get maximum charge current into your battery. Features a wide array of applications and systems, with variable battery mode selection and operation modes, as well as low voltage disconnect and reconnect for the connected load output (15A max). To make this unit even more flexible, multiple units can be "stacked" in parallel to increase current capacity. Suitable for 12V or 24V systems.

- Intelligent MPPT technology
- Automatic system voltage detection (12V or 24V)
- Charge current: 40A
- Stackable to increase current capacity
- 3-stage charging (bulk, absorption, float)
- Reverse polarity, over temperature, over current, overcharge and overload protections
- Selectable equalisation charge
- LED indicators for charge status, operation mode and fault detection
- Dimensions: 192(L) x 140(W) x 66(D)mm

MP-3737

NEW 2011

$349.00

NOTE: This unit cannot charge a 12V battery from a 24V solar panel, or vice-versa. Battery bank and solar panels must have the same nominal voltage.

Automotive

3.5" LCD CAR DASH-MOUNT COLOUR MONITORS

Ideal reversing camera monitors that mount perfectly on your vehicles dashboard. Partner these LCD monitors with any video source for in-car entertainment. With two composite input options, the rear vision view is automatically activated when your reversing gear is engaged. Both models are powered by 12VDC.

3.5" Foldable TFT LCD Monitor

This TFT LCD monitor folds down to a compact shell for dust protected storage and to keep the driving line of sight unobstructed.

- High resolution display • TFT active matrix system
- Auto switching PAL (4.43MHz) and NTSC (3.58MHz)
- Included: RCA cable & adhesive mounting sticker

QM-3771

$89.00

3.5" LCD Monitor

Supplied with an adjustable swivel bracket and a clip on sun shade for optimal viewing.

- Brightness, colour, contrast and tint controls
- Automatic mirror image selector for reversing camera
- Included: mounting bracket & sunshade
- Dimensions: 100(W) x 87(H) x 25(D)mm

QM-3792

$79.00 NEW 2017

CAR AMPLIFIER WIRING KITS

Complete wiring kits for installing an amplifier into your vehicle. Everything you need, down to the cable ties and screws. Save $$ on the individual parts.

8G Wiring Kit

- Includes: 6m x 8G power cables, 9m x 16G speaker wire, 5.2m stereo RCA interconnect, 5.2m 18G remote wire, gold plated fuse holder, 40A fuse, loom tubing, gold plated crimp connectors, grommets, cable ties & self-tapping screws

AA-0442 WAS $59.95

$49.95 SAVE $10.00

4G Wiring Kit

- Includes: 5.2m x 4G power cables, 9m x 16G speaker wire, 5.2m stereo RCA interconnect, 5.2m 18G remote wire, gold plated fuse holder, gold plated battery terminal, 40A fuse, loom tubing, gold plated crimp connectors, grommets, cable ties & self-tapping screws

AA-0444 WAS $99.00

$79.00 SAVE $20.00

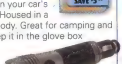
1W LED TORCH WITH IN-BUILT CAR CHARGER PLUG

This super-bright 1W LED torch conveniently recharges in your car's cigarette lighter socket. Housed in a robust aluminium alloy body. Great for camping and the outdoors; or just keep it in the glove box in case of emergencies.

- Dimensions: 160(L) x 35(D)almm

SL-3381 WAS $19.95

$14.95 SAVE $5.00



HOT DEAL OF THE MONTH

VIFA Car Subwoofers

Produce high quality sound. With dual voice coils, high power handling and die-cast aluminium chassis, they don't just sound brilliant, but will also deliver SPL when you want it.

VIFA 10" Subwoofer

- 200WRMS @ 2 x 4 ohms

CS-2351 $199.00

VIFA 12" Subwoofer

- 250WRMS @ 2 x 4 ohms

CS-2353 $269.00

HOT DEAL

Buy VIFA Subwoofer (CS-2351 or CS-2353) & Get Enclosure to suit (CS-2526 or CS-2527) valued at minimum $39.95 FREE!

Subwoofer Enclosures

Dual ported subwoofer enclosures with black carpet covering. Designed for optimal performance with the Vifa 10" and 12" subwoofers. All you need to do is to add the driver of your choice.

10" Subwoofer Enclosure

- Volume: 40.6 litres
- Dimensions:480(W) x 360(H) x 280(D)mm

CS-2526 $39.95

12" Subwoofer Enclosure

- Volume: 48.6 litres
- Dimensions:520(W) x 385(H) x 290(D)mm

CS-2527 $49.95

FROM **$39.95**

NOTE: VIFA driver not included.

7" TFT LCD WIDESCREEN COLOUR MONITOR WITH IR REMOTE

Delivers high resolution pictures in widescreen format and clear sound reproduction through its inbuilt speaker. Lightweight and suitable for mobile and fixed monitoring applications. Two RCA composite video inputs and one audio input are provided for a multi source system. A truly versatile monitor with low power consumption, wide viewing angle and NTSC and PAL compatible. Unit comes complete with an adjustable swivel bracket, infrared remote control, 4 pin mini DIN to 2 RCA and power cable.

- 7" TFT screen display
- Power input: 12VDC
- Composite video signal
- Ideal for rear seat passengers

QM-3752

$159.00

CAR AND MAINS MOBILE PHONE CHARGER PACK NEW 2017

The handy solution to charge your mobile phone in the car or home. Included is a cigarette lighter USB car charger and a mains USB charger, each capable of delivering 5VDC up to 1A via a USB output. The pack also includes a universal USB charging lead with 4 interchangeable tips to match all the most common mobile phones.

- Car Charger Input: 12 - 24VDC
- Mains Charger Input: 100 - 240VAC
- Dimensions: Car Charger: 100(L) x 36(W) x 31(H)mm Mains Charger: 69(H) x 41(W) x 39(D)mm

MB-3655

$29.95

CAR DISPLAYS NEW 2017

Indoor/Outdoor Car Thermometer with Clock

Ideal for keeping track of the temperature when you're on the road. The unit plugs into the vehicle's cigarette lighter socket for power and also features an inbuilt clock.

- Input voltage: 12 - 24VDC
- Selectable blue or white LCD display
- Inside cable length: 2m
- Outside cable length: 3m
- Dimensions: 86(L) x 34(H) x 21(W)mm

XC-0114

$29.95

LED Panel Meters

Simple and easy to install self-powered meters with voltage or current display. The voltmeter has a simple 2-wire connection, and the current meter has 4-wire connection with an included current shunt. Auto zero calibration and easy to read red LED display. Perfect for automotive, caravan or 4WD use. Cut-out size 42 x 23mm.

- Automatic polarity sensing
- Power requirements: 8 - 30VDC
- Sample frequency: 400mS

FROM **$24.95**

LED Voltmeter 0 - 30V DC

- Measurement range: 0 - 30VDC
- Maximum display count: 999

QP-5586 $24.95

LED Ammeter 0 - 50A DC

- Measurement range: 0 - 50A
- Maximum display count: 1999

QP-5588 $39.95

NOTE: When connecting the ammeter QP-5588 it is essential that the wiring instructions provided with the product are followed; or the meter may be destroyed.

3 Point Car Engine Immobiliser HOT

This high quality fully featured engine immobilizing car alarm passed the latest 2001 Australian and New Zealand Standards AS/NZS 4601:1999 - Vehicle Immobilisers. The Shadow meets and exceeds insurers' requirements by having the required standard two internal immobilizing circuits as well as a third external immobilizing circuit. Alarm components available separately (LA-8975), allow the user to add alarm functionality. See website for features and information.

- Micro-processor controlled technology
- All wiring is black & same gauge to confuse thieves
- Panic button personal safety feature
- Armed ground output to control accessories
- Remote central locking (if car fitted with central locking)

$139.00

Car Immobiliser includes:

- Black box electronic module
- 2x 433MHz code-hopping remote control key fobs
- High security all-black wiring harness (numbered for installation purposes), including central locking output wiring
- Flashing dashboard LED
- Installation and user manuals

LA-8970

SHADOW

Alarm Upgrade includes:

- Multi-Tone 20 watt Battery Back-Up Siren with security key shut-off
- Shock Sensor (adjustable sensitivity settings)
- Bonnet Pin Switch (protects engine bay from tamper)
- Supplementary Installation booklet

LA-8975 **$49.95**

HOT DEAL

Buy Car Immobiliser (LA-8970) & Get 50% OFF the Upgrade Pack (LA-8975) SAVE $24.95

BE SEEN, BE SAFE

LED Bike Light Kit

NEW 2011

Outputs 190 lumens and has an adjustable focus beam. Mount the torch onto 25 to 31mm handlebars with the adjustable bracket or detached it becomes a conventional torch. The kit also includes an ultra-bright rear safety light with flashing and continuous modes. Designed to clip onto your belt, bicycle saddlebag or back pack.

$39.95

Headlight/torch:
- Batteries: 3 x AAA (not included)
- Dimensions: 105(L) x 32(Dia)mm

Taillight:
- Batteries: 2 x AAA (not included)
- Dimensions: 60(L) x 35(H) x 26(D)mm

ST-3465

Flexible LED Safety Lights - Pair

A pair of handy press-down LEDs that have two modes of operation, blinking and constant on. Each LED is encased in flexible silicone that can be wrapped around bicycle handlebars or a helmet strap.

NEW 2011

- Each unit requires 2 x CR2032 batteries (included)
- Dimensions: 75(L) x 29(W) x 29(H)mm

ST-3136

$9.95

BOOK LIGHT

Designed to be portable and practical! The light has two brightness levels and uses a super bright 0.5W LED to fill your page with light and make reading a breeze. With its flexible gooseneck it can be positioned in any way required.

- On/Off switch with dimmer
- Requires 1 x AAA battery
- Gooseneck length: 250mm long
- Dimensions: 40(W) x 105(L) x 10(D)mm

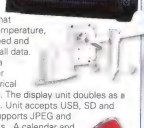
ST-3205

NEW 2011

$9.95

WIRELESS WEATHER STATION AND DIGITAL PHOTO FRAME

This full function weather station has a 7" LCD that displays all the parameters in full colour. It has two easy to mount outdoor wireless weather sensors that will transmit the temperature, humidity, wind speed and direction, and rainfall data. It will also display a barometric weather forecast with historical pressure bar graph. The display unit doubles as a digital photo frame. Unit accepts USB, SD and MMC cards and supports JPEG and slideshow functions. A calendar and alarm function is also integrated in this feature packed device.



NEW 2011

- Wireless anemometer & rain gauge
- Resolution: 800 x 480 Pixels
- Memory: USB flash drive, SD & MMC card
- IR remote control included
- Supports slideshow & JPG format
- Dimensions: 235(L) x 161(H) x 41(D)mm

XC-0357

$249.00

NEW RUST RESISTANT SPEAKER SYSTEMS - IP55

At last, speakers for your boat that will never rust. No metal grills, all plastic. Will work in any outdoor environment, however best to keep out of direct weather. This unit is completely moulded in high density UV resistant plastic. The only metal parts exposed are the mounting bracket and the speaker terminals.

5" IP55 30WRMS - 2 WAY

- Speakers 5" woofer, 2" tweeter. Passive crossover
- Power handling: 30WRMS
- Dimensions: 215(W) x 155(H) x 115(D)mm

CS-2479

NEW 2011

$149.00

6.5" IP55 40WRMS - 2 WAY

- Speakers: 6.5" woofer, 2" tweeter. Passive crossover
- Power handling: 40WRMS
- Dimensions: 265(W) x 195(L) x 145(D)mm

CS-2480

$179.00

Sold as a pair

HIGH INTENSITY DISCHARGE (HID) SPOTLIGHT

NEW 2011

A powerful 30 million candle power HID hand held spotlight with amazing beam distance. Fully featured with inbuilt rechargeable SLA battery, 240V and 12V charger and swing away stand. Also includes a dual-led map light.

- 35W HID bulb
- Massive 135mm reflector diameter
- Dimensions: 280(L) x 190(D) x 140(W)mm (less reflector)

ST-3379

$99.00

38 CHANNEL UHF TRANSCEIVER

Featuring a 38 channel hand-held transceiver with up to 3km range. Perfect for camping, picnics in the bush, skiing and hiking trips. It also features an integrated LED torch so you can find your way home in the dark. Requires 3 x AAA batteries.

- Integrated Blue LED Torch
- Push to Talk (PTT) function
- Electronic volume control
- Scan channel, call tone and monitor functions
- Low battery alert
- Duplex function
- Dimensions: 122(H) x 54(W) x 35(D)mm

DC-1008

*Limited quantity - Be quick!

$19.95

HOT DEAL

Buy 2 for $30 SAVE $9.90

SOLAR OUTDOOR LIGHTS - EASY INSTALL!

Solar Outdoor Wall Lamp With Sound Sensor

Ideal for illuminating outdoor paths, walkways or as a spotlight above a garage door. It is weatherproof, heatproof and durable with over 12 hours run time in one day charge. The unit has a light and sound sensor, and is easy to install with mounting bracket and screws included.

- Solar panel 0.55W
- Li-ion battery 3.7V 800mAh
- 1W LED light
- Auto delay
- Expansion pillar hinge included
- Dimensions: 35(H) x 124(L) x 91(W)mm

SL-2767

NEW 2011

$39.95

Solar LED Spotlight Kit

Add a light to the garden shed, carport, entrance door or even for a wandering pet. The 135 x 87mm solar panel mounts anywhere you can catch some rays and the 9 LED spotlight can be mounted wherever it's needed. The light turns on when the PIR sensor detects movement, then automatically turns off after a time delay.

- 3 x AA rechargeable batteries included
- Cable length 3m

SL-2752 WAS $39.95

$29.95 SAVE $10.00

RECHARGEABLE MAGNETIC WORK LIGHT

Perfect for boating, camping, working on the car or for emergencies. With 61 super bright LEDs, it provides enough light for any situation. Equipped with two powerful magnetic clip-on brackets for fixing metal surfaces, leaving your hands free. It can be recharged with a mains charger or via a car cigarette lighter outlet.

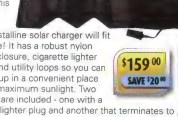
- Water, oil and shock resistant
- Recharging time: 3 hrs
- Mains and car chargers included

ST-3021 WAS $49.95

$29.95 SAVE $20.00

FOLDING SOLAR CHARGER

Folding to a compact bundle, this versatile 10W monocrystalline solar charger will fit anywhere! It has a robust nylon fabric enclosure, cigarette lighter socket, and utility loops so you can tie them up in a convenient place to catch maximum sunlight. Two lead sets are included - one with a cigarette lighter plug and another that terminates to alligator clips. Ideal for camping, 4WD, boating, caravans or motorhome holidays.



- Suitable for 12V lead acid batteries
- Folds up for compact easy storage
- Dimensions: Open: 750(L) x 220(W)mm Folded: 250(L) x 100(W) x 40(D)mm

ZM-9120 WAS $179.00

$159.00 SAVE $20.00

Limited stock on sale items. All Savings are based on Original RRP

HOT Bargains

BARGAIN PHOTO SCANNERS

Convert photo prints, slides and negative films to digital images, making it easy to archive, share and keep precious memories alive!

USB Photo Scanner

Simply install the included software, connect the photo scanner to your computer via USB and you're ready to start scanning. Features an 8 megapixel sensor and white LED lighting and it will produce clear high resolution scans quickly. It also enables you to do basic photo editing such as crop, straighten, retouch and colour adjust. See website for full specs and system requirements.

- Four photo sizes: 3.5 x 3.5, 3.5 x 4.5, 3.5 x 5.0, 4.0 x 6.0 inches
- PC & MAC compatible
- USB 2.0

XC-4910 WAS $129.00

$99.00 SAVE $30.00

USB Combo Image Scanner with LCD

Versatile and easy-to-use combo scanner. With USB connection, you can connect this to your PC and take high resolution scans of all your photos, 35mm slides and negatives to preserve in JPEG or TIF format. It also features a handy memory card slot and LCD so you have the option to preview and transfer all your scans directly to memory card without the need for PC connection.

- 2.4" LCD preview panel
- Dual modes - film/slide scanner & photo scanner
- 35mm negative holder and slide holder
- 3 x photo holders - 3 x 5", 4 x 6" and 5 x 7"
- SD, XD, MMC, MS, MS-Pro memory card slot
- Power via USB connection
- Dimensions: 210(L) x 230(W) x 150(H)mm

XC-4893 WAS $199.00

$179.00 SAVE $20.00

MICROSCOPES

Power Microscope Kit

This power microscope enables you to see the closest details under a monocular eyepiece or projection screen. Easy to assemble and comes with a ready made specimen for immediate exploration of the microscopic world. See website for full kit contents.

- Requires 2 x AA batteries
- Size: 110(W) x 80(D) x 240(H)mm

QC-3243 WAS $29.95

$19.95 SAVE $10.00

3-in-1 USB Microscope

Explore the miniature world with your microscope. Use it as a conventional optical microscope, a digital microscope or snap the USB camera into the top and capture images to your PC or Mac. Includes slides, eyedropper and a set of tweezers.

- Software included
- Magnification: 50 - 100x, 100 - 200x, 200 - 400x
- Requires 2 x AA batteries
- Size: 112(W) x 132(D) x 260(H)mm

QC-3241 WAS $89.00

$69.00 SAVE $20.00

VIDEO ENHANCER & STABILISER

The stabiliser feature of this unit is designed to remove as many extra signals as possible to produce a cleaner, better quality PAL composite video signal for recording or viewing. The system will also remove some copy protection information.

- Mains plugpack & RCA cable supplied

AR-1822 WAS $99.00

$89.00 SAVE $10.00

12VDC MAGLEV & HYDRODYNAMIC FANS

Long-Life Low-Noise Maglev Bearing Case Fans

Featuring a patented Nanoflux bearing that incorporates magnetic levitation technology, these premium quality fans ensure an extremely long operational life, extremely low noise levels compared to traditional ball bearings, and also offers the ability for the fan impeller to be removed for cleaning. Dust and waterproof to IP54 , these fans are sure to last even in harsh conditions. See our website for full specifications.

- 12VDC
- Flylead with 3 pin molex connector
- Polycarbonate housing
- UV reactive polycarbonate impellers

12VDC 80mm	YX-2580	$24.95
12VDC 90mm	YX-2582	$29.95
12VDC 120mm	YX-2584	$34.95

NEW 2011

Silent Hydro-Dynamic Bearing Case Fans

Designed to provide additional airflow without increasing noise levels. Features balanced blades, long-life hydro-dynamic bearing and ultra-low noise making these fans perfect for a home theatre, PC, or ventilating the amplifier wedged into your entertainment unit.

NEW 2011

- 12VDC
- Polycarbonate housing and impellers

12VDC 80mm	YX-2570	$19.95
12VDC 90mm	YX-2572	$24.95
12VDC 120mm	YX-2574	$28.95

5.8GHZ WIRELESS AV SENDER

Send audio and video signals around the house from practically any video source - DVD, VHS, set-top box, cable TV etc. Operating on the 5.8GHz band keeps it free from interference on the 2.4GHz band and an external omni-directional antenna provides a transmission range of up to 100 metres.

- 8 channel for minimal interference
- External IR extension cord
- Dimensions: 120(L) x 88(W) x 34(H)mm

AR-1880 WAS $89.00

$74.00 SAVE $15.00

MOTORISED FLAT TV BRACKETS

HOT

With the touch of a button, swivel or tilt your LCD or plasma TV either manually or to a pre-programmed position noiselessly. The mount will fit standard VESA 200, 300 or 400mm. Ideal for TVs that are concealed behind panels or TVs in commercial environments like pubs, waiting rooms, clubs or conference rooms etc. Remote included.

Two versions available:

30kg

- Projection distance: 150mm
- TV weight: 10 - 30kg

CW-2835 WAS $299.00

$229.00 SAVE $70.00

50kg

- Projection distance: 180mm
- TV weight: 30 - 50kg

CW-2837 WAS $499.00

$399.00 SAVE $100.00

MINI DVR KIT WITH BUTTON-HOLE COLOUR CAMERA

Capture meetings, conferences or lectures with this high definition video and audio mini DVR kit. Store up to 32GB on an SD card, then allow you to view the video on the 2" TFT LCD colour screen with different buttonhole options so it's completely covert and discreet. Includes a li-ion rechargeable battery, charger, AV leads, USB cable and dummy buttons for disguising the camera.

HOT

- Approx 10 hours of video on 32GB SD card (not included)
- 128MB flash memory
- Camera resolution 420TV lines
- Dimensions: DVR: 65(W) x 64(H) x 14(D)mm Camera: 22(W) x 34(H) x 15(D)mm

QC-8006 WAS $249.00

$199.00 SAVE $50.00

DMM HOT PRICES!

HOT

Inductance/Capacitance/Frequency DMM

Feature-packed DMM with inductance and capacitance. Ideal for audio enthusiasts designing their own crossovers. Features large LCD and 30-minute auto power-off. Includes carry case and temperature probe. See website for full specifications.

- Display: 2000 count
- Dimensions: 194(H) x 91(W) x 44(D)mm

QM-1324 WAS $44.95

$34.95 SAVE $10.00

Rechargeable Solar DMM

An environmentally friendly DMM with rechargeable batteries that can be charged from the built-in solar panel, 12-36VDC or from mains power. Never buy batteries again.

- Display: 2000 count
- Dimensions: 179(H) x 88(W) x 39(D)mm

QM-1546 WAS $119.00

$69.00 SAVE $50.00

Cat III Dynamo-Powered DMM

Just crank the handle for 10 seconds to provide power for approx. 10 minutes operation. Ideal for electrical emergencies on the car or boat. The unit also has provision to be powered by 2 x CR2032 batteries for those days when kinetic energy is not available.

- Display: 4000 count
- No batteries required
- Data hold
- 10A current
- Dimensions: 152(L) x 78(W) x 45(D)mm

QM-1547 WAS $79.95

$44.95 SAVE $35.00

All meters include: quality test leads!

HOME SECURITY HOT PRICES!

2.4GHz Baby Monitor System with Portable LCD & Night Vision

Monitor your baby sleeping or your kids at play in the backyard. Features a portable 2.4" colour LCD and CMOS colour camera with inbuilt mic. The monitor unit conveniently recharges in the included charging cradle. With 2.4GHz digital transmission, signals are more stable, clearer and interference free up to 100m range. The camera unit features infrared night vision and voice activation mode to keep you alert throughout the night.

$169.00 SAVE $30.00

- Lightweight
- Rechargeable li-ion battery and recharging cradle for monitor unit
- Adaptor or battery powered camera unit
- 4-channel operation

QC-3251 WAS $199.00

HOT

2.4GHz Wireless Colour Video Doorphone

A compact wireless video doorphone that's full on features. Incorporating digital encryption and code-hopping 2.4GHz wireless transmission, signals are clear and interference-free up to 100m range. The receiver unit features a high definition 3.5" TFT LCD, stores up to 200 images and a built in rechargeable battery. The camera unit is equipped with a wide angle lens IR illumination and is easy to install.

$249.00 SAVE $50.00

- Clear night vision
- Mini USB for PC interface
- Rechargeable lithium battery
- Dimensions: 290(W) x 210(H) x 50(D)mm

QC-3253 WAS $299.00

RACK MOUNT CAT 5e/6 PATCH PANELS

Rack mount 24 port patch panel with a hard metal exterior. Numbered ports and a labelling area for each port. Comes with instruction stickers on the back for easier cabling.

- Takes up 1 rack unit
- Cat 5e or Cat 6

NEW 2011

FROM $49.95

24 Port Patch Panel Cat 5e YN-8046 $49.95
24 Port Patch Panel Cat 6 YN-8048 $69.95

ON-LINE 1000VA 700W UPS

HOT

This quality true online UPS is designed for critical loads. It provides a perfectly clean sinewave output no matter what the mains throws at it. Covered for surges, spikes, noise, brownouts and blackouts for as long as the batteries last. A backlit LCD shows the operating status and advises of any fault condition. It also provides an RS-232 interface so the UPS can be connected to a computer and used with the included management software. See website for full specifications.

MORE INFO AT WWW.JAYCAR.COM.AU

$499.00 SAVE $100.00

- 2 x 240V outlets
- Software included
- Batteries: 2 x 12V 7Ah
- Backup power: 1000VA
- Backup time: 7 mins at 50% load
- Dimensions: 400(L) x 145(W) x 210(H) mm

MP-5210 WAS $599.00

802.11N USB WIRELESS NETWORK ADAPTOR

This superb adaptor can be used on older laptops without built-in wireless capabilities or to improve the data throughput of newer machines that only have ordinary 802.11g functionality.

$29.95 SAVE $10.00

- Supports infrastructure and ad-hoc modes
- Supports SONY PSP®, Nintendo Wii® and NDS®

YN-8304 WAS $39.95

3 IN 1 STUD DETECTOR WITH LASER LEVEL

Featuring a stud detector which doesn't just "beep" when you're over the stud, instead it shows the proximity when you are NEAR a stud via the large LCD and shows a target graphic when you're spot on. Also featuring live wire (voltage) detection, and best of all is the built in laser level.

- Laser levelling, layout & stud locating on vertical and horizontal surfaces
- Wood, metal & live wire detection
- LCD sensing & mode display with target graphics
- Powered by 9V battery (included)
- Size: 190(H) x 67(W) x 38(D)mm

$49.95

NEW 2011

QP-2288

NEW RANGE OF DIGITAL MULTIMETERS

NEW 2011

Autoranging Pocket DMM

A handy pocket DMM with plenty of features. Large LCD display with 4000 count, autoranging measurement with data hold and relative functions, and replaceable leads make this a perfect companion to any technician, field engineer, mechanic, or even a handyman.

- Pocket sized
- Auto power-off
- Capacitance
- Frequency, duty cycle
- Dimensions: 115(H) x 60(W) x 16(D)mm

$29.95

Includes Test Leads!

QM-1328

Automotive DMM with Inductive Pickup

A multimeter for all your automotive diagnostic needs. Features an inductive pickup for RPM measurement, dwell angle, frequency, duty cycle, data hold, relative function, backlit display and temperature, and works with engines of 2 to 10 cylinders. An absolute must have for the backyard mechanic or qualified tradesperson alike.

- RPM x1, x10
- Resistance
- DC volts
- Frequency
- Dimensions: 146(H) x 66(W) x 42(D)mm

$59.95

NEW 2011

Probes, alligator clip probes & holster included

QM-1444

True RMS Cat IV DMM with Wireless USB & Storage

Includes Test Leads!

Features double moulded case for impact resistance and IP67 waterproof protection. This meter can also be used as a data logger with its data storage capability, which can then be connected to a PC via wireless USB interface keeping the PC completely isolated from whatever is being measured. Also features triple LCD backlit screen with bargraph, data hold, 4-20mA process loop measurements, capacitance range and many more features. A truly fantastic multimeter designed to last you several years out in the field.

- Wireless USB PC interface
- PC logging software
- 399 measurement storage
- Auto power-off
- Relative measurement
- Diode test
- Autoranging
- 10A current range
- Dimensions: 182(H) x 82(W) x 55(D)mm

NEW 2011

$199.00

QM-1575

TEST & MEASUREMENT BARGAINS!

Automotive Blade Fuse Current Meter

The quick and easy way to measure current in automotive circuits. Simply plugs into blade type fuseholder and displays the current draw on the LCD display.

$59.00 SAVE $40.00

- 3.5 digit display
- Bargraph, peak-hold and data-hold function
- Measurement range: 0 - 80A
- Dimensions: 112(L) x 45(W) x 33(D)mm

QP-2257 WAS $99.00

HOT

Cat IV Fixed Jaw Clampmeter

The ideal test instrument for electrical contractors. Compact and light with probe storage in the back for easy one-handed operation. Jaw opening is 16mm.

$99.00 SAVE $80.00

- Non-contact voltage sensor
- Data hold
- Auto power-off
- Diode test
- Audible continuity test
- Display: 2000 count
- Dimensions: 190(H) x 62(W) x 42(D)mm

QM-1567 WAS $179.00

HOT

Autoranging SMT DMM

Specifically designed for SMT work with interchangeable probes and tweezer probes. Probes will connect across all standards surface mount components without danger of short circuit.

- Autoranging
- Continuity test
- Auto power-off
- Display: 6000 count
- Dimensions: 110(H) x 36(W) x 21(D)mm

$39.95 SAVE $30.00

QM-1496 WAS $69.95

PA Systems & Party Audio

NEW RANGE OF HEADPHONES

Professional Monitor Headphones

Affordable professional headphones that offers outstanding performance. Provides accurate, linear sound reproduction to cater for the most demanding monitoring applications. Comes with comfortable ear cushions to provide hours of fatigue-free listening.

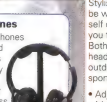
- Driver diameter: 42mm
- Power handling: 120mW
- Nominal impedance: 64 ohms

AA-2065

$99.00

2.4GHz Digital Wireless Headphones

These soft leatherette foam padded headphones have full ear cup design to shield unwanted external noise and incorporate easy access to volume, power and tuning controls. Easy to use, just plug the transmitter into a computer, iPod®, Hi Fi unit, TV, radio or any audio device for the convenience of wireless personal audio. The mains adaptor is used for powering the transmitter unit and also for recharging the headphones.



- Built-in volume control
- 3.5mm auxiliary input
- 3.5mm - RCA adaptor
- Mains adaptor/charger included

AA-2074

$99.00

DJTECH PORTABLE RECHARGEABLE SPEAKER WITH AMPLIFIER

Perfect for parties, beach, schools, auditoriums or a street performance. Simple and easy to use, simply plug in your iPod®, CD player, MP3 player or microphone and you're ready to go. Includes rechargeable batteries with a runtime of about 12 hours so you can set it up and keep it running for the duration of the performance. The unit includes a wireless hand-held microphone and a wireless transmitter for lapel or lavalier microphone attachment.

- 50WRMS output
- Battery powered with built-in rechargeable battery
- Bass reflex enclosure
- 3 channel mixer with tone control on master
- Adjustable talk over for microphone priority
- Made with 12mm wood and carpet
- 6.5" customized coaxial woofer
- 35mm pole mount for installation
- Weight: 8kg
- Dimensions: 264(W) x 273(H) x 264(D)mm

CS-2513

$299.00

HOT DEAL

FREE Nylon Carry Bag (CS-2511) valued at $29.95 with every purchase!

12" SUBWOOFER

HOT DEAL

FREE Protective Speaker Cover (CS-2582) valued at $24.95 with every purchase!

High performance subwoofer. The cabinet is finished in leatherette vinyl and houses a 12", 4 ohm sub-woofer rated at 300WRMS and protected by a steel mesh grille. The speaker system is perfect for boosting the bass frequencies of music systems in bars, clubs, and parties etc. DJs will love it.

- Speaker Size: 12"
- Power handling: 300WRMS
- Weight: 30kg
- Enclosure Size: 480(W) x 580(H) x 440(D)mm

CS-2518

$199.00

WIRELESS INDOOR/OUTDOOR STEREO SPEAKERS

NEW 2011

Stylish indoor/outdoor speakers ideal for garden entertainment or for home cinema where space does not allow for trailing wires. The 2.4GHz DIGITAL audio transmitter ensures noise-free transmission up to 30m range. The transmitter charges either via supplied power adaptor or by micro USB and speakers are powered via 6 x AA batteries (not included) or by supplied power adaptor.

- Mood light option
- Dimensions: Speakers: 250(H) x 130(Dia)mm Transmitter: 90(D) x 35(H)mm

AR-1891

$169.00 Pair

BELT PACKS PORTABLE PAs

NEW 2011

Stylish portable PA speaker designed to be worn around the waist. These fully self contained amplified speakers allow you to be heard over a crowd or noisy environments. Both units are supplied with a comfortable wired headset microphone with flexible boom. Suitable for outdoor activities, lectures/ presentation, aerobics, sports, etc. Two models available both with:

- Adjustable belt
- Mains charger included
- Aux audio input
- 1000mAh rechargeable battery

Portable PA 3.5" Speaker

- Basic model with 3.5mm auxiliary audio input for MP3 or iPod® connectivity

AM-4060

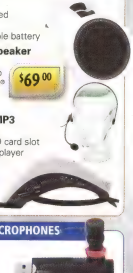
$69.00

Portable PA with MP3 Player 4" Speaker

- Unit includes USB/SD card slot with integrated MP3 player

AM-4062

$119.00



NEW RANGE OF MICROPHONES

USB Microphone

This low cost USB uni-directional condenser microphone offers great performance and versatility. The pickup assembly rotates through 180 degrees for optimum efficiency. A 3.5mm jack is provided for monitoring your work with headphones.

- Compatible with Windows XP, Vista, 7 & Mac OS10.4+
- Type: USB unidirectional
- Polar pattern: Cardioid
- Termination: USB 2.0 plug

AM-4104

NEW 2011

$24.95

Great for podcasting

USB Dynamic Microphone

Plug and play with any recording software or the recording interface on your PC for superior sound quality on your next podcast or home recording masterwork.

- Easy connectivity
- High sound quality
- 16 bit resolution
- 48kHz sampling rate
- Type: USB unidirectional dynamic
- Termination: 3m cable, USB 2.0 plug

AM-4103

NEW 2011

$39.95

No batteries, no drivers required!

DJ EQUIPMENT

HOT

Compact USB Media Player and Controller

A USB compatible digital music controller that has the power to cue, play, manipulate and even scratch digital files. Add some FX in real time, plug and play your MP3s without any booting or searching time. It supports external USB mass storage devices up to 90GB. See our website for full specifications.

- DSP effects
- Multi function JOG mode
- Firmware upgradeable
- VBR & CBR file support
- Dimensions: 204(W) x 215(H) x 93(D)mm

AA-0499 WAS $349.00

$279.00 SAVE $70.00

Rack-Mount Dual DJ CD Player

For mobile DJs looking for a basic, reliable, dual CD player to use in professional situations.

Covers all the features professional DJs require, like anti-shock, cue control and seamless looping. Other features include IR remote control, quality transports, analogue and digital audio outputs, pitch blending and rack mounting.

- 2 units (controller and player)
- Backlit LCD
- Tactile silicone rubber buttons
- Compatible with CD, CD-R, CD-RW
- Anti-shock buffer memory
- Dimensions: Player unit: 482(W) x 90(H) x 255(D)mm Controller: 482(W) x 90(H) x 85(D)mm

AA-0491 WAS $299.00

$249.00 SAVE $50.00

USB MIDI Mixer with Virtual DJ Software

Mix, play and scratch your own MP3 tracks directly from your PC. All you need is a computer and some MP3 tracks. The mixer gives you the control you lose when going from a traditional mixer to a laptop. It sends MIDI data from the controller to your DJ software without the inconvenience of mouse control. It's a fully class-compliant USB MIDI device and complete with Virtual DJ software. See our website for full features and specifications.

- 2-deck controller
- Mix 2 files in 1 controller
- USB powered
- Dimensions: 368(W) x 260(H) x 45(D)mm

AM-4252 WAS $299.00

$249.00 SAVE $50.00

NETWORK 16 CHANNEL H.264 DVR WITH 500GB HARD DRIVE

NEW 2017

This H.264 DVR incorporates a 16 channel multiplexer and is fitted with an on-board Ethernet connection allowing you to access the DVR remotely. Connect to a network and access the recorder with a standard browser or via a Smartphone app for iPhone®, iPad® HD, Android, or Windows Mobile. The system utilises password authentication to avoid unauthorised use and you can enable offsite access if a broadband connection is present on site. The DVR supports large SATA hard drives and is fitted with a 500GB drive. The system has a USB port for file transfer but can also support a USB DVD recorder. This is a sophisticated and versatile DVR with a host of features normally only be present on more expensive models.

500GB Hard disk drive included

- iPhone® and Smartphone support
- 16 channel multiplexer
- 10/100 Base-T Ethernet connections
- Full control from remote locations
- Digital recording in MPEG-4 H.264 format
- Full search functions
- Video loss detection
- Password protection
- Alarm input and output
- Resolution: 720 x 576 pixels (PAL)
- Video output: Composite video & VGA (up to 1600 x 1200)
- Recording rate: Up to 480IPS
- Dimensions: 430(W) x 338(D) x 65(H)mm

QV-8103

$899.00

Free iPhone/iPad app available on the iPhone® and iPad® App Store

GOOSENECK USB COLOUR CMOS INSPECTION CAMERA

This goosneck camera offers a wide array of application including checking under vehicles, inside cupboards, behind wall cavities, inside engines, up chimneys etc. The camera head has built-in LEDs with variable brightness control. Completely portable & powered by USB.

$49.95 SAVE $10.00

- Software drivers & magnetic attachment included
- LED illuminators
- Dimensions: Camera head: 62(L) x 14(Dia)mm Goseneck: 580(L) x 9.5(Dia)mm

QC-3388 WAS $59.95

4 CHANNEL WIRELESS DIGITAL MINI DVR SYSTEMS

These mini DVR systems operate on the 2.4GHz DIGITAL band which means stable, interference free transmissions. No cabling means easy set up. Great for a wide range of applications. Two models are available, both include one colour outdoor day/night camera with motion sensor, a ball & socket mounting bracket, and utilise channel hopping to prevent interference. Both have easy to navigate system settings, manual recording, schedule recording or record with motion detection. Both use SD cards (not included) to store video and playback is via the SD card to a PC.

2.4GHz Digital Wireless Receiver with Camera
QC-3630

$299.00

QC-3630

HOT

2.4GHz Digital Wireless Display/ Receiver with Camera and Integrated 7" LCD
QC-3632

$399.00

QC-3632

Additional or spare cameras available:
Mains powered QC-3634 $189.00
Solar powered QC-3633 $249.00

8 CHANNEL CCTV POWER SUPPLY WITH BATTERY BACKUP OPTION

NEW 2017

This handy CCTV power supply supplies power to a multiple camera installation and can provide power backup when you install a backup battery. When mains power is provided the backup battery (available separately - use our SB-2486) is charged, but when mains power is interrupted, the unit powers the load from the backup battery. Protection against would be thieves decide to cut the power.

- Requires backup battery: 12V 7Ah size SLA fuse our SB-2486)
- Over current, short circuit and over voltage protection
- Separate battery charging circuit with fast changeover and low battery voltage cut-off
- Each DC output has fuse and varistor protection
- LED indicators for power, backup and charge
- Output: 12VDC, 5.0A maximum (8 separate outputs)
- Dimensions: 263(L) x 195(W) x 64(D)mm

MP-3855

$149.00

*See online or in-store for our full range of professional cameras.

MINI DVR AND BULLET COLOUR ACTION CAMERA PACKAGE

NEW 2017

Record and re-live the thrills of your action sport. Mount the camera and screen on your body, helmet or handlebars using one of the four mounts, then record video and audio to the 256MB built-in memory or to an SD Flash card (1GB - 32GB, not included). Playback on the 2.5" colour screen or output to a larger screen using the AV output. Rechargeable 3.7V 1400mAh battery can be charged via USB or using the supplied AC mains charger, and will provide 180 mins of recording for a 240mins charge time.

$269.00

- Camera: colour CMOS (curly cord extends to 1m)
- Video Format: AVI (MPEG-4)
- AC mains charger, USB driver disc, leather case, camera bracket and mounting hardware, USB lead, AV in/out cable, and manual included.
- Dimensions: Camera: 60(L) x 14(D)mm Monitor/Recorder: 75(W) x 55(H) x 20(D)mm

QC-8015

BRIEFCASE AMORPHOUS SOLAR CHARGERS

NEW 2017

Convenient briefcase sized solar chargers for keeping a car battery topped up while on holidays or in storage. Three sizes for small, medium and large cars or 4WDs. Each terminates in a cigarette lighter plug or alligator clips.

FROM $39.95

12V 2W Charger
- Dimensions: Closed: 185(L) x 154(W) x 34(H)mm Open: 304(L) x 185(W) x 17(H)mm

ZM-9036 $39.95

12V 4W Charger
- Dimensions: Closed: 237(L) x 229(W) x 34(H)mm Open: 445(L) x 237(W) x 17(H)mm

ZM-9037 $49.95

12V 7W Charger
- Dimensions: Closed: 335(L) x 250(W) x 36(H)mm Open: 492(L) x 335(W) x 18(H)mm

ZM-9038 $79.95

10 ZONE WIRED ALARM KITS

Fully configurable and programmable, these alarm kits give you complete control over a professional system for home or business. Each supplied with a central controller and the sensors you need to get a basic system up and running, then you can add sensors and functionality as required. Up to four remote keypads can be installed at up to 100m range and each can be named for easy identification. Each user can be programmed with any of four access level codes. Any zone can be programmed for security, PA, fire or 24 hour tamper and can be fully or partially armed.

- 10 programmable zones • 4 access levels • Walk test mode
- Events memory in keypads
- Programmable timers for entry, exit and alarm duration

Alarm with LED Controller
- 1 x Control panel
- 1 x Remote LED controller
- 2 x PIR sensors
- 1 x Reed Switch
- 1 x Bellbox
- 1 x 50m 6 core cable
- 1 x 12V 1.2Ah backup battery

LA-5560
WAS $299.00

$279.00 SAVE $20.00

LA-5560

Alarm with LCD Controller
- 1 x Control panel
- 1 x Remote LCD controller
- 4 x PIR sensors
- 2 x Reed Switch
- 1 x Bellbox
- 2 x 50m 6 core cable
- 1 x 12V 1.2Ah backup battery
- 1 x Internal siren

LA-5562
WAS $399.00

$359.00 SAVE $40.00

LA-5562

Gadgets & Gizmos

CAMERA MOUNT FOR MOTORBIKES & BICYCLES

NEW 2011

This unit enables you to mount a video or still camera clamped to the handlebars of a bike via a standard 1/4" mount. Cameras can be removed quickly and safely via a spring-loaded locking mechanism.

- Handle bar clamp range from 21 to 28mm dia.
- Measures: 75(H) x 44(W) x 60(L)mm (At max height)

QC-3805

$9.95

ROBOT CHASSIS KITS - BUILD IT YOURSELF

Robot Chassis/Platform - Light Duty

This kit uses a piece of rigid fibreglass circuit board as the vehicle chassis. It has a generous area at the front for circuit prototyping, subassembly mounting, etc. It includes 2 x drive motors, gear sets and fastener hardware. The motors share a common lay shaft but are otherwise independent. An axle with 40mm dia rubber tyres are included, as well as a sturdy ball caster which act as the 3rd 'wheel'. The chassis could be easily extended to accommodate a second axle/wheel assembly (not included in kit).This chassis platform could form the basis of, say, a line following robot. Kits like this solve the hard-to obtain parts for robotics projects.

- Hand tools, including a small soldering iron will be needed for assembly
- Suitable for ages 12+
- Chassis dimensions:140(L) x 85(W)mm (max)

KR-3132

$34.95

NEW 2011

Robot Chassis/Platform - Heavy Duty

The vehicle chassis is an extremely rigid, glass reinforced ABS plastic case, which is almost unbreakable. Comes assembled with 2 x 6V motors with gear trains. Each motor is securely fitted to a 48mm dia. driving cog, which independently drives a rubber caterpillar track. The other end is freewheeling, but there is access to a drive shaft on each side. These could accommodate position sensors, or other motors. There are slots in the chassis for PCBs, no electronics is included (6 x AA battery holder is included). Accessories included - gear grease, Allen key.

- High quality, high integrity product
- Suitable for ages 12+
- Chassis dimension (overall): 172(L) x 190(W) x 60(H)mm

KR-3130

$69.95

NEW 2011

HIGH PERFORMANCE STOPWATCH

High performance stopwatch perfect for timing laps. Will do 999 laps and splits, fastest, slowest & average lap display and can count rowing stroke rates. Up to 100 lap times stored in memory. Lithium battery included, black in colour and comes with lanyard.

- Pacer function
- Dual timer
- Dimensions: 68(L) x 82(W) x 21(H)mm

XC-0287

$24.95

NEW 2011

WIRELESS "OBJECT LOCATOR"

Locate misplaced objects such as keys, TV remote, glasses, wallet etc. Simply connect receivers by double sided tape or lanyard to frequently misplaced item, press the master transmitter (colour coded) and the lost item beeps back. Range 7-10 metres.

- Supplied: 1 x keyfob transmitter, 3 x separate receivers
- Dimensions: transmitter: 60(L) x 32(W) x 7(D)mm (receivers slightly smaller)

XC-0354

$29.95

NEW 2011

KIT OF THE MONTH

3-Step MPPT Solar Charge Controller

Charge controllers are essential for solar setups, although commercial units can run into several hundred dollars. Designed for use with 40W to 120W 12V solar panels and lead acid batteries, this solar charger provides 3-stage charging with the option of equalisation and with MPPT (Maximum Power Point Tracking). Operation is for 12V and the kit configured for this voltage, a 24V upgrade will be available in future. Kit includes PCB, all components and case.

- Suitable for 40W to 120W 12V solar panels
- 3-step charging
- Charge indicator LEDs
- Temperature compensation for charge voltage
- Optional equalisation cycle
- Optional 24V 80W to 240W operation upgrade

KC-5500

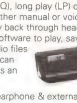
$129.00

DIGITAL VOICE RECORDERS

HOT

512MB Digital Voice Recorder

Record up to 270 hours of voice, notes or music in high quality (HQ), long play (LP) or short play (SP) modes with either manual or voice-activated recording. Play back through headphones or use the included software to play, save or edit the audio files on your PC. It can also be used as an MP3 player.



- USB cable, earphone & external mic included
- External mic input
- Requires 2 x AAA batteries
- Date and time-stamped recordings
- Dimensions: 111(L) x 28(W) x 14(H)mm

XC-0381

$49.95

4GB Digital Voice Recorder

With 4GB capacity and stereo capability, this recorder quickly record musical ideas in either High Quality, Long Play or Short Play and to play back MP3 tracks. Play back through headphones or the built-in speaker. Great for students and business meetings.

- Up to 1080 hours recording
- Supports MP3/WMA/ACT formats
- Built- in lithium-ion rechargeable battery
- USB cable, user manual, earphone & external mic included
- Dimensions: 85(L) x 34(W) x 11(H)mm

XC-0383

$99.00

NEW 2011

0.5W Rechargeable LED Lantern

Ideal for home use, outdoor sports and camping etc. Being weatherproof it is also suited for emergency situations or during periods of extreme climate conditions where lighting is essential. Not only does it incorporate three lighting options in one but you also have the ability to control the mode and brightness by rotating the knob. Supplied with cigarette lighter socket, mini USB cable and 3 x AAA rechargeable batteries.

- 360° rotating mode switch
- 6 x LED Lantern
- 0.5W LED Torch
- Dimensions: 62(L) x 140(H)mm

ST-3121

$34.95

NEW 2011

YOUR LOCAL JAYCAR STORE - Free Call Orders: PH 1800 022 888

AUSTRALIAN CAPITAL TERRITORY

Belconnen	Ph: (02) 6253 5700
Fyshwick	Ph: (02) 6239 1801

NEW SOUTH WALES

Albury	Ph: (02) 6021 6788
Alexandria	Ph: (02) 9699 4699
Bankstown	Ph: (02) 9709 2822
Blacktown	Ph: (02) 9678 9669
Bondi Junction	Ph: (02) 9369 3899
Brookvale	Ph: (02) 9905 4130
Campbelltown	Ph: (02) 4620 7155
"NEW" Castle Hill	Ph: (02) 9634 4470
Coffs Harbour	Ph: (02) 6651 5239
Croydon	Ph: (02) 9799 0402
Erina	Ph: (02) 4365 3433
Gore Hill	Ph: (02) 9439 4799
Hornsby	Ph: (02) 9476 6221
Liverpool	Ph: (02) 9821 3100
Maitland	Ph: (02) 4934 4911
Newcastle	Ph: (02) 4965 3799
Penrith	Ph: (02) 4721 8337
Port Macquarie	Ph: (02) 6581 4476
Rydalmere	Ph: (02) 8832 3120
Sydney City	Ph: (02) 9267 1614
Taren Point	Ph: (02) 9531 7033
Tweed Heads	Ph: (07) 5524 8566
Wagga Wagga	Ph: (02) 6931 9333
Wollongong	Ph: (02) 4226 7089

NORTHERN TERRITORY

Darwin	Ph: (08) 8948 4043

QUEENSLAND

Aspley	Ph:(07) 3863 0099
Caboolture	Ph: (07) 5432 3152
Cairns	Ph: (07) 4041 6747
Capalaba	Ph: (07) 3245 2014
Ipswich	Ph: (07) 3282 5800
Labrador	Ph: (07) 5537 4295
Mackay	Ph: (07) 4953 0611
Maroochydore	Ph: (07) 5479 3511
Mermaid Beach	Ph: (07) 5526 6722
Nth Rockhampton	Ph: (07) 4926 4155
Townsville	Ph: (07) 4772 5022
Underwood	Ph: (07) 3841 4888
Woolloongabba	Ph: (07) 3393 0777

SOUTH AUSTRALIA

Adelaide	Ph: (08) 8231 7355
Clovelly Park	Ph: (08) 8276 6901
Gepps Cross	Ph: (08) 8262 3200
Reynella	Ph: (08) 8387 3847

TASMANIA

Hobart	Ph: (03) 6272 9955
Launceston	Ph: (03) 6334 2777

VICTORIA

Cheltenham	Ph: (03) 9585 5011
Coburg	Ph: (03) 9384 1811
Frankston	Ph: (03) 9781 4100
Geelong	Ph: (03) 5221 5800
Hallam	Ph: (03) 9796 4577
"NEW" Kew East	Ph: (03) 9859 6188
Melbourne	Ph: (03) 9663 2030
Ringwood	Ph: (03) 9870 9053
Shepparton	Ph: (03) 5822 4037
Springvale	Ph: (03) 9547 1022
Sunshine	Ph: (03) 9310 8066
Thomastown	Ph: (03) 9465 3333
Werribee	Ph: (03) 9741 8961

WESTERN AUSTRALIA

"NEW" Joondalup	Ph: 1800 022 888
Maddington	Ph: (08) 9493 4300
Midland	Ph: (08) 9250 9200
Northbridge	Ph: (08) 9328 8252
Rockingham	Ph: (08) 9592 8000

Arrival dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. **Prices valid from 24th July to 23rd August 2011.** All savings are based on original RRP

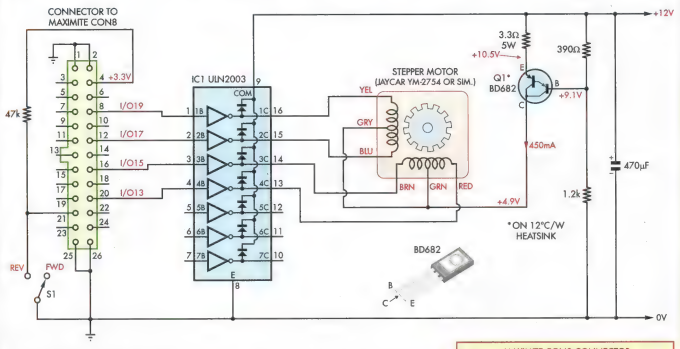
Head Office
320 Victoria Road, Rydalmere NSW 2116
Ph: (02) 8832 3100 Fax: (02) 8832 3169

Online Orders
Website: www.jaycar.com.au
Email: techstore@jaycar.com.au

jaycar
Better. More. Technical.

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.



Maximite stepper motor interface

This simple circuit and program listing allows the Maximite microcomputer (SILICON CHIP, March-May 2011) to control a stepper motor. It could be expanded to allow for the control of multiple motors, with four of the Maximite's external I/O pins used to control each motor with identical driver circuits.

A ULN2003 Darlington transistor array (IC1) switches current through the stepper motor's two windings in either direction. When one of the four Maximite output pins (8, 12, 16 & 20, corresponding to I/Os 19, 17, 15 & 13) goes high, the corresponding output pin on IC1 goes low, sinking current through a motor winding. Conversely, when these pins are high, the corresponding Darlington transistor is off and so no current flows through that portion of the winding.

The centre tap of each motor winding is connected to a current source comprising PNP Darlington transistor Q1 and some resistors. The maximum current is determined by the resistive divider driving its high-impedance base, setting the base voltage to around 9.1V when it is fully on.

By adding Q1's base-emitter voltage (1.4V at 0.5A, as per the data sheet) we can determine that there will be around 1.5V across the 3.3Ω resistor (12V - 10.5V), resulting in a current of 1.5V ÷ 3.3Ω = ~450mA.

Transistor Q1 must be fitted with a medium-sized flag heatsink (Jaycar HH8504, Altronics H0637) or larger to handle its maximum dissipation of (10.5V - 4.9V) x 450mA = 2.5W.

When one of the Darlington transistors switches off and current flow through the corresponding motor winding ceases, the inductive winding generates a back-EMF current which causes the voltage across that winding to spike. IC1 has internal "free-wheeling" diodes from each output to the COM pin, which is connected to the +12V supply.

The back-EMF current flows back into the power supply and the voltage spikes are clamped at about 12.7V, so that the Darlington transistors do not suffer collector reverse breakdown, which might damage them.

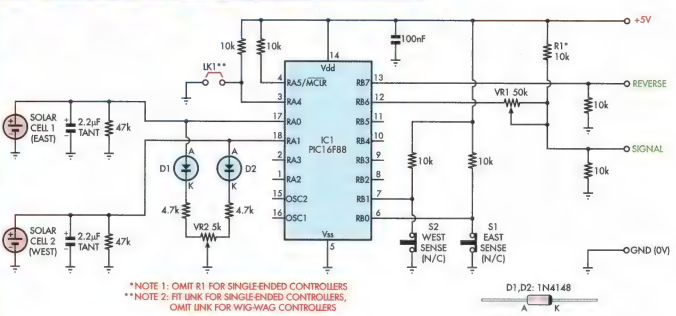
A 470µF capacitor provides supply bypassing for the motor while a 47kΩ pull-up resistor and toggle switch/pushbutton S1 drives input pin 9 of the Maximite, allowing manual control of the motor direction.

Table 1 shows the sequence in which the output pins are driven to turn the motor forward; the steps are run backwards for reverse operation. The delay between the steps determines the speed at which the motor rotates.

The source code of the sample program is available for download from the SILICON CHIP website (maximite_stepper_motor.bas).

L. Kerr,
Ashby, NSW. ($60)

MAXIMITE CON8 CONNECTOR				
	PIN8	PIN12	PIN16	PIN20
STEP 1	0	1	1	0
STEP 2	0	1	0	1
STEP 3	1	0	0	1
STEP 4	1	0	1	0



Solar tracking with a standard motor speed controller

While commercial solar tracking devices are available, they tend to cost more than typical motor speed controllers and are not as common. This circuit can drive most standard motor speed controllers to keep a solar panel, solar heater or similar device aimed at the Sun throughout the day.

Two photocells (ie, solar cells) are used to sense the Sun's position. For the prototype, these were scrounged from two identical solar-powered calculators. One is mounted on the east side of the rig and one on the west, as shown. When more light falls on the west sensor than the east sensor, after a short delay the motor is driven forwards to tilt the platform until the light levels on the two sensors are again equal.

This results in the panel slowly changing from an east-facing orientation to a west-facing orientation over the course of the day. When the Sun sets, both sensors go dark and the motor is put into reverse, returning the panel to an east-facing position, ready for sunrise. Normally-closed limit switches (S1 & S2) stop the motor when the panel reaches its maximum tilt in either direction.

When the Sun is blocked by clouds, this is detected as a drop in voltage from both sensors and motor movements are prevented. Otherwise, sunlight reflecting off clouds could cause spurious movements.

Many bidirectional motor controllers use a 0-5V control signal with 2.5V for stop, higher voltages for forward motion (at an increasing speed up to 5V) and lower voltages for reverse motion. This is sometimes referred to as "wig-wag control" and this mode of operation is selected when link LK1 is open.

Other controllers use a 0-5V signal to control the motor speed and a second digital signal to reverse the direction. A unidirectional motor controller can be modified to use this scheme with the addition of a motor reverse relay and logic-input relay drive circuitry. This mode of operation is also supported by the circuit, with LK1 shorted and resistor R1 removed.

It works as follows. Each photocell is loaded with a resistive path to ground via two 1N4148 diodes (D1 & D2), so the output voltage is roughly proportional to the light falling on the sensor. The diodes lighten the load at low voltages, increasing the dynamic range (ie, the ratio between the highest and lowest distinguishable light levels).

Trimpot VR2 is used to trim out sensor variations; it's adjusted for identical output voltages at the same light level.

Contribute And Choose Your Prize

We pay for each of the "Circuit Notebook" items published in Silicon Chip but there are three more reasons to send in your circuit idea. Each month, at the discretion of the editor, the best contribution published will entitle the author to choose a prize: an LCR40 LCR meter, or a DCA55 Semiconductor Component Analyser, with the compli-

ments of Peak Electronic Design Ltd – see www.peakelec.co.uk

So now you have even more reasons to send that brilliant circuit in. Send it to Silicon Chip and you could be a winner.

You can either email your idea to silicon@siliconchip.com.au or post it to PO Box 139, Collaroy, NSW 2097

Microcontroller IC1 reads the sensor output voltages using its internal analog-to-digital converter at pins RA0 and RA1. It senses whether link LK1 is installed and whether either limit switch has activated using digital inputs RA4, RB0 and RB1 respectively, each with a 10kΩ pull-up resistor.

The motor control signal is generated from output RB6 of IC1. To stop the motor, RB6 is set to high impedance and the control voltage is held at 2.5V by a 10kΩ/10kΩ voltage divider between +5V and ground. To drive the motor forwards, RB6 goes high, increasing this voltage by an amount set by potentiometer VR1. For reverse, RB6 goes low, reducing the control voltage by the same amount.

If VR1 is set to minimum resistance, the motor speed is at maximum since RB6 can drive the control voltage over the full 0-5V range. As VR1's resistance is increased, the control voltage authority is reduced, slowing the motor.

For motor controllers requiring a separate reverse signal, omit resistor R1 and use the additional signal at pin RB7. Without R1, the control voltage is held at 0V when RB6 is at high impedance and increases when RB6 goes high. As before, VR1 controls the speed but link LK1 must be installed so that RB6 is driven high for both directions.

It is possible to adapt this circuit to use different light sensors such as photo-transistors and light-dependent resistors (LDRs). The circuit should be configured so that the voltages at pins RA0 and RA1 increase as more light falls on the corresponding sensor. For photocells, ensure that the output does not exceed 3V in bright sunlight (when loaded) or this could damage IC1.

For very directional sensors, a perpendicular shadow-plate may be necessary (adjacent to or between the sensors) to provide improved feedback.

The software for the PIC16F88 microcontroller (IC1) is available for download from the SILICON CHIP website (solar_tracking_adaptor.zip).

Herman Nacinovich, Gulgong, NSW. ($60)

Audio impedance meter operates at 1kHz

This circuit uses a Colpitts oscillator based on transistor Q1 to provide a 1kHz sinewave signal. This is fed to an LM386 power amplifier (IC1) via potentiometer VR1 which sets the input level.

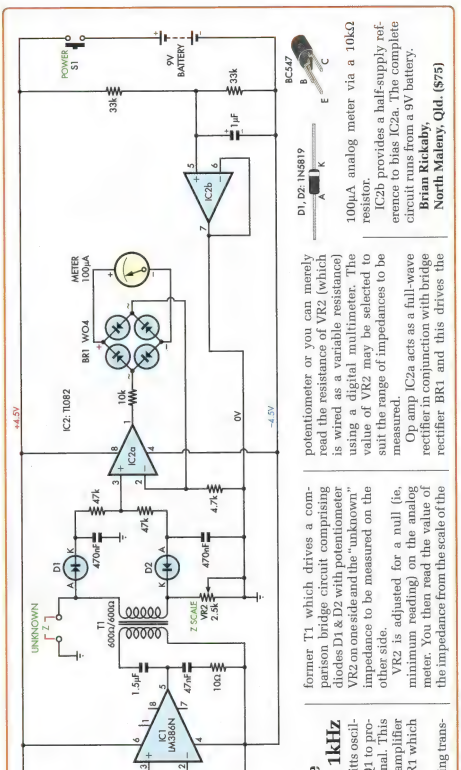
IC1 drives a 600Ω isolating transformer T1 which drives a comparison bridge circuit comprising diodes D1 & D2 with potentiometer VR2 on one side and the "unknown" impedance to be measured on the other side.

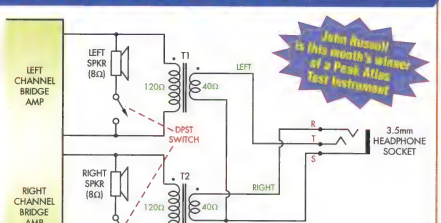
VR2 is adjusted for a null (ie, minimum reading) on the analog meter. You then read the value of the impedance from the scale of the potentiometer or you can merely read the resistance of VR2 (which is wired as a variable resistance) using a digital multimeter. The value of VR2 may be selected to suit the range of impedances to be measured.

Op amp IC2a acts as a full-wave rectifier in conjunction with bridge rectifier BR1 and this drives the 100μA analog meter via a 10kΩ resistor.

IC2b provides a half-supply reference to bias IC2a. The complete circuit runs from a 9V battery.

Brian Rickaby, North Maleny, Qld. ($75)





Stereo headphone adaptor for LCD & plasma TVs

Most modern flat-panel TVs do not have a headphone socket. In many cases, they don't have audio line outputs either. A simple way to add a headphone output to a device with speakers is to simply wire a switched jack socket to the internal amplifiers. This is connected so that when headphones are plugged in, the internal amplifiers are disconnected from the speakers and connected to the headphones via a current-limiting resistor instead.

Unfortunately, this doesn't work with many modern TVs because their speakers are driven in bridge mode, ie, neither end is connected to ground. Instead, the positive and negative terminals are both actively driven with signals of opposite polarity (commonly with Class-D amplifiers). Since headphones have a single ground connection for both earpieces, there's no way to wire up a bridged stereo amplifier to drive headphones directly.

This was the situation with an LG 19LH20R 19-inch LCD TV and the solution was to fit it with a pair of small inter-stage coupling transformers taken from old AM radios. The 120Ω primaries are wired across the bridged amplifier outputs, with a DPST switch to disconnect the speakers when headphones are used. The secondaries connect to a headphone socket and can be grounded at the common end (ie, the sleeve connection).

These iron-cored transformers give good audio performance. Also, their step-down ratio reduces the signal amplitude to a more suitable level for headphones. If you don't have some in your junk box, you could instead try Altronics M0212B audio-coupling transformers (10kΩ:2kΩ) or Jaycar MM2532 audio output transformers (1kΩ:8Ω) with the higher impedance end driven from the amplifiers.

Telephone line isolation transformers (600Ω:600Ω) may also be suitable but are more expensive.

A primary-to-secondary winding ratio from about 3:1 to 8:1 should give an appropriate output voltage (depending on the headphone sensitivity and amplifier output levels). The Jaycar MM2532 has a ratio of around 11:1 (square root of its impedance ratio) so if using them, connect the amplifiers across half of each primary using the centre tap to reduce the step-down ratio to a more useful 5.5:1.

You can also wind your own transformers on suitable cores. Regardless of the transformers used, ensure that they are connected with the same polarity.

John Russell,
Bangkok, Thailand.

Editor's note: it is true that most TVs with class-D amplifiers effectively have bridged outputs, with neither side of the speakers connected to chassis. However, an alternative method of connecting headphones may be to simply connect to one side of each speaker via a resistor of, say, 220Ω with the common headphone connection going to chassis in the conventional way.

Shunt regulator for battery float charging

It's sometimes desirable to keep a lead-acid battery on "float" charge so that it is always ready to go, eg, in the event of a black-out. This involves holding its terminal voltage at a specific level, usually 13.6-13.8V, to overcome self-discharge and to prevent the plates from becoming sulphated, which would reduce its capacity and ultimately destroy it.

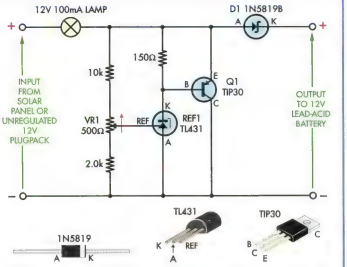
Since only a small amount of current is required to keep the battery topped up, one way to float charge a battery is to shunt regulate the output of a plugpack or small transformer. The shunt regulator operates as an additional load in parallel with the battery, varying its current draw to maintain a constant terminal voltage.

The advantage of using a shunt regulator is that it has zero dropout, ie, the output voltage can be as high as the input voltage (with the shunt regulator behaving as a high impedance). The disadvantage is that such circuits are inefficient as they can draw more current than the load under some circumstances.

If a shunt is placed directly across the power supply, it is able to decrease the supply voltage by increasing its current draw since all supplies have a finite output impedance. But this may involve pulling a lot of current; this can be substantially reduced if a resistance is connected between the power supply and the shunt regulator/load. This effectively increases the power supply's output impedance and therefore allows the shunt regulator to reduce the voltage by drawing less current.

This circuit uses a 12V 100mA lamp between the power supply and the battery. Incandescent lamps act as a non-linear resistance; when the filament is cold, they present a low resistance (typically no more than 10% of nominal; 12Ω in this case). As the current increases and the filament heats, the resistance increases too. The resulting current/resistance relationship is ideal for this application.

This regulator is based on a TL431 adjustable shunt regulator IC. The



IC can pass up to 100mA by itself, within its modest dissipation limit (about 750mW at 25°C). With the addition of PNP transistor Q1 as a pass element, the current and power capability is boosted to 1A and 30W (with adequate heatsinking).

The simplest way to use a TL431 is to connect its REF ("reference") pin to its cathode and then it behaves like a very accurate 2.5V zener diode. But by connecting a resistive divider between its anode and cathode, with the centre point tied to the REF pin, the "breakdown voltage" is increased by the division ratio factor, to a maximum of 36V.

The TL431 controls its anode-cathode voltage by varying its transconductance depending on the voltage at the REF pin. If this voltage is too high, it increases its transconductance, allowing more current to pass through and vice versa. This regulates the voltage as described above.

Since Q1's base is connected to IC1's cathode, as IC1 increases its transconductance, more current flows through Q1's base-emitter junction. This causes the current through Q1's collector-emitter junction to increase by an even larger factor than the increase through IC1 alone (as determined by Q1's current gain) and so most of the shunted current passes directly through Q1, not IC1.

With VR1 centred, the voltage across Q1 is around 2.5V x (12,500Ω / 2250Ω) = 13.9V. Taking into account the forward voltage of reverse polarity protection diode D1 of about 0.2-0.3V (typical for a high-current Schottky diode), the battery receives about 13.6-13.7V.

To set the output voltage accurately, connect the battery (or a dummy load such as a 1kΩ resistor) and measure the voltage across it while adjusting VR1. This cancels any error due to inaccuracies in IC1's internal reference or variations in resistor value. The power supply voltage must be slightly higher than the desired output voltage (about 14V is ideal).

The prototype was powered from a 12V 150mA plugpack. With a light load, most linear (transformer-based) plugpacks put out about 20-25% more voltage than they are rated to deliver at full current. Small solar panels can also be used. Q1 should not need a heatsink for solar panels up to 2W or small linear plugpacks or mains transformers.

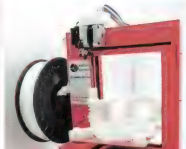
David Eather,
Toowoomba, Qld. ($50)

UP! DESKTOP 3D PRINTER

The affordable UP! 3D Printer transforms your designs into 3D, tough ABS or PLA plastic models, right from your desktop into your hands.

The UP! Desktop printer is small enough to fit on your desk, easy to use and affordable. Light enough to transport and share.

Education
Product Design
Engineering
Automotive
Electronics
Medical
Art
Design
Jewellery
Rapid Prototype
CAD Teaching
Mechatronics
Robotics



Unique Features

- Reliable
- High accuracy
- Low cost of ownership
- Minimum 0.2mm layer
- Not a kit
- Fully tested and approved
- Heated build plate
- Simple removal of parts
- Automatic support creation
- Link to unique laser scanner
- Easy to transport

Easy to use

- Ready to run in short time
- No training needed
- Easy to operate
- Simple to maintain
- Email and phone assist

Consumables

- ABS- white and colours
- PLA - low temperature

Spares

- Heaters, nozzles, extruders

Included software

- Opens STL format
- Print Preview (time,mass)
- Layers: .2/.25/.3/0.35/.4mm
- Speed: Slow,normal,fast
- User set of raft density
- User set of fill density
- User angle for support
- Autoplacement of part
- Scale,move,rotate
- Array for multiple copies
- Material usage counter
- Calibrate and initiliase
- Origin set up
- Extrude,retract filament
- Firmware ROM upgrade
- Download and run

Specifications

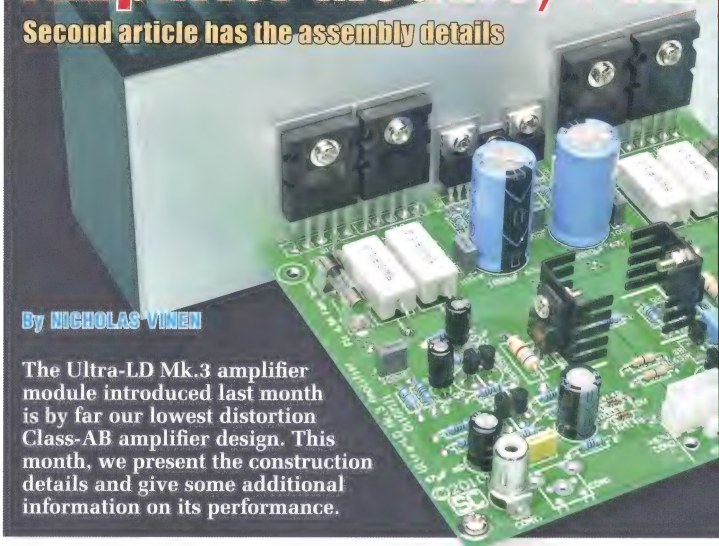
Platform: 140x140x140mm
Print heads: 1
Support: Auto and low density
Dimension: 345x260x350mm
Weight: 5Kg
Power: 220W, universal packs
Connection: USB
OS: Windows and Mac
Included: Tools, ABS
Warranty: 12 months to base

Contact:
Intellecta Technologies Pty Ltd
51 George St, Thebarton SA 5031
ph: 08 8351 8288, email: support@intellecta.net
Web: www.intellecta.net

PRINTING SYSTEMS AUSTRALASIA
AUTHORISED SOLUTION RESELLER

Ultra-LD Mk.3 200W Amplifier Module; Pt.2

Second article has the assembly details



By NICHOLAS VINEN

The Ultra-LD Mk.3 amplifier module introduced last month is by far our lowest distortion Class-AB amplifier design. This month, we present the construction details and give some additional information on its performance.

BUILDING THIS new high-performance amplifier module is really quite straightforward although there's a fair amount of work involved. When building a high-power amplifier like this, it's important to take your time and double-check each stage of the assembly as you proceed.

The double-sided PCB shown in the photos is critical to the performance of this module. It not only simplifies the supply wiring but has also been carefully designed to largely cancel the magnetic fields produced by the asymmetric currents drawn by each half of the class-B output stage.

In addition, the double-sided board eliminates the need for wire links, the exception being a couple of 0Ω resistors.

We'll describe how to assemble the module shortly but first let's take a look at a few more aspects of the design.

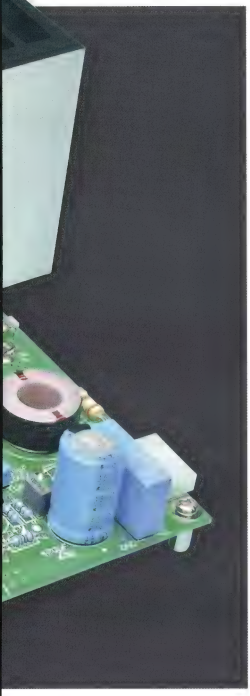
Increased fuse rating

The previous Ultra-LD Mk.2 had two on-board 5A fuses which we changed in the Mk.3 to 6.5A (7.5A is also OK). That's because the amplifier is capable of delivering around 300W of music power into 4Ω. Under this condition, each fuse carries around 4.4A RMS (including the quiescent current). It could be even higher with a highly reactive speaker load.

While this is unlikely to blow a 5A fuse, it could eventually lead to fuse failure due to thermal stress. We have not had any reports of blown fuses in the Mk.2 version but we thought it best to make the change anyway.

Inductor value

The Ultra-LD Mk.3 amplifier uses a higher value inductor (10μH) than



previously for better distortion cancellation. This results in slightly worse high-frequency response for 4Ω loads (the difference with an 8Ω load is insignificant), the response being -1dB at 20kHz compared to -0.7dB.

We feel that -1dB at 20kHz is acceptable. If you really want the extra 0.3dB though, you can have it in exchange for slightly higher distortion (peaking at 0.0048% at 20kHz rather than 0.0038%). All you have to do is wind the inductor with five fewer turns of wire.

Either way, its orientation and winding direction are very important. The reason is that the current flowing through this coil creates a magnetic field that partially cancels the magnetic field generated by the speaker current loop on the PCB.

With a positive output voltage, the speaker current flows in a clockwise direction around the loop which includes the 10µH inductor and the speaker. However the current in the coil itself flows in an anti-clockwise direction and so the magnetic fields partially cancel. This reduces the magnetic coupling back to the input stage.

As described later, the inductor itself is actually wound in a clockwise direction. It must also be installed exactly as shown on the PCB layout diagram (Fig.10), otherwise the distortion will be higher than it otherwise would be.

If you have already built an Ultra-LD Mk.2 amplifier, check its inductor orientation. If it's the wrong way around, its 20kHz distortion figure will be around 0.012% rather than the specified 0.006%.

Input filtering

As stated last month, the 4.7nF capacitor at the amplifier's input (increased from 820pF in the Mk.2) provides better RF signal attenuation. This prevents radio signals picked up by the input leads from being rectified and amplified by input transistor Q1. The value chosen assumes a low source impedance (ie, 220Ω or less) which suits most modern program sources (eg, CD or DVD players).

If RF pick-up is still a problem (unlikely), the input filter can be improved by using a 4.7nF ceramic capacitor. This will have less inductance than an MKT type and so its impedance is lower for RF signals. A ferrite bead can also be slipped over the 100Ω resistor lead between the input connector and this capacitor, further increasing RF attenuation.

Note that a 4.7nF input capacitor will cause an audible reduction at high frequencies if the signal source impedance is too high, so a lower value (eg, 1nF) should be used in that case.

Resistor ratings

The 6.8Ω 1W snubber resistor in the output filter is adequately rated for music or speech at maximum power. However, if the amplifier is made to deliver high-frequency signals at high power (eg, during testing), this resistor can overheat and burn out.

To avoid this, you can use a 6.8Ω 5W wirewound resistor instead. The final board design has extra pads for fitting a larger resistor, which can sit on top of the adjacent 2.2kΩ resistor. This should withstand a continuous 20kHz output at 135W into 8Ω or 100W into 4Ω.

Frequency response

Last month, we published the frequency response plots for 4Ω and 8Ω loads, showing the low and high-frequency roll-off. However, we didn't show the no-load frequency response.

Because of the output filter, the no-load response is actually up by +0.3dB at 20kHz. For more details on this condition, see Neville Thiele's paper "Load Circuit Stabilising Network for Audio Amplifiers" (Proceedings of the IREE 299, September 1975).

No-load operation of the amplifier will only occur when it is driving headphones (ie, via the on-board 390Ω 1W resistor), so it is of little consequence.

Alternative transistors

The amplifier's second (transimpedance) stage (also called the voltage amplification stage or VAS) incorporates two medium-power transistors with flag heatsinks, Q7 (BF470) and Q9 (BF469). These were selected for good linearity. Each dissipates around 15mA x 57V = 855mW continuously, so small signal transistors are not suitable.

Unfortunately, BF469s and BF470s are becoming harder to acquire because they were designed for cathode ray tube (CRT) driver circuits. With the advent of LCD and plasma TVs, the demand has dropped dramatically and so they can be hard to get.

As a result, we have made provision for alternative parts from Toshiba:

WARNING!

High DC voltages (ie, ±57V) are present on this amplifier module when power is applied.

In particular, note that **there is 114V DC between the two supply rails.** Do not touch the supply wiring (including the fuseholders) when the amplifier is operating, otherwise you could get a lethal shock.

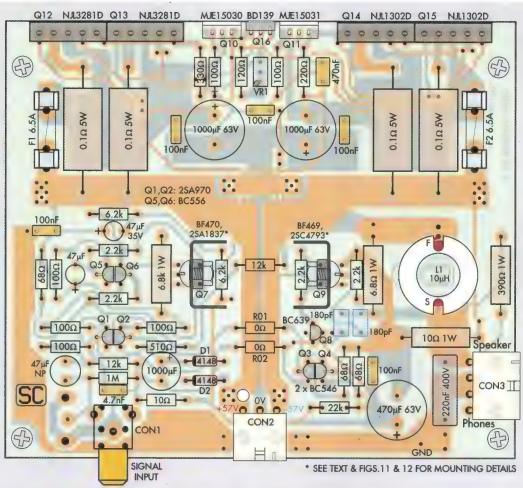


Fig.10: follow this parts layout diagram to build the Ultra-LD Mk.3 Amplifier module. Note that you should install a tinned copper wire feed-through in the middle of each group of five vias. Note also that this overlay shows the arrangement for BF470 & BF469 transistors for Q7 & Q9 while the photo at right the alternative arrangement when using 2SA1837 & 2SC4793 transistors.

2SA1837 (PNP, replaces Q7) and 2SC4793 (NPN, replaces Q9). These are designed for audio amplifier use and are still in production. They are currently available from DigiKey.

Note, however, that their pinouts are reversed compared to the BF469/BF470 so we added an extra set of pads on the opposite side of each small heatsink. The slightly different assembly method is explained later in this article (see also Figs.11 & 12).

In fact, using these alternative transistors gives a slight reduction in high-frequency distortion compared to the BF469/BF470 combination, ie, the THD + N at 20kHz is reduced from .0038% to .0031% at 100W into 8Ω (the graphs published last month were generated using BF469/BF470).

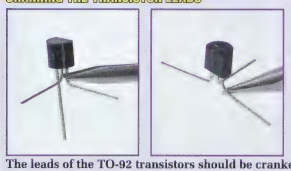
PCB assembly

Fig.10 shows the parts layout on the PCB. Before starting the assembly though, it's a good idea to carefully inspect the board. This will not only familiarise you with its layout but will also reveal any defects (however unlikely).

Next, to prevent the high-current vias on the board from fusing if there is a fault, solder wire feed-throughs to the six vias with pads. You can use tinned copper wire or component lead off-cuts. Solder these feed-throughs on both sides and then trim off the excess.

The next step is to install all the small (0.25W or 0.5W) resistors. Check each value using a digital multimeter set to Ohms mode before soldering it in place (the colour bands can sometimes be difficult to read). That done,

CRANKING THE TRANSISTOR LEADS



The leads of the TO-92 transistors should be cranked to fit their mounting holes in PC board using a pair of needle-nose pliers. Here's how it's done.

This fully-assembled module uses 2SA1837 & 2SC4793 transistors for Q7 & Q9 (note how they are mounted) plus the optional vertical connectors for CON1 & CON2. Make sure the inductor (L1) goes in with the correct orientation.

install the two small 1N4148 diodes with their striped ends to the left, as shown on the overlay diagram.

Follow with the four 1W resistors (or three, if you are upgrading the 6.8Ω resistor), again being careful to check the values. The two 180pF polypropylene capacitors can then go in, along with the 4.7nF and 100nF MKT capacitors.

Fit the small signal transistors in the TO-92 packages next. There are four different types so read the markings carefully and be sure to install the correct type at each location. Note that their leads should be cranked using needle-nose pliers so that they fit properly – see the adjacent panel.

You can now solder in the four 0.1Ω 5W resistors. These should be mounted about 2mm proud of the PCB so that air can circulate beneath them for cooling. A cardboard spacer slid under the resistor bodies before soldering their leads can be used to ensure consistent spacings.

The four M205 fuse clips are next. Press them down fully onto the board before soldering and ensure that the retention clips are on the outside (if in doubt, test-fit a fuse but remove it before soldering so that it won't be heat-damaged).

The best approach is to fit a dummy fuse to hold the fuse-clips in position, then tack solder them on the top of the PCB first. They can then be soldered to the pads on the underside of the PCB.

The 10μH inductor is next on the list. It must be orientated as shown, with its start (S) lead (ie, the one nearest the centre of the bobbin) going through the pad on the PCB nearest the 10Ω 1W resistor.

Now fit the connectors, ie, the RCA socket and the two Molex plugs. These should all should be installed flat on the board. Check that each is perpendicular to the adjacent PCB edge before soldering it in place.

Note that either vertical or horizontal connectors can be used for the

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	1MΩ	brown black green brown	brown black black yellow brown
1	22kΩ	red red orange brown	red red black red brown
1	12kΩ	brown red orange brown	brown red black red brown
1	6.8kΩ	blue grey red brown	blue grey black brown brown
2	6.2kΩ	blue red red brown	blue red black brown brown
4	2.2kΩ	red red red brown	red red black brown brown
1	390Ω	orange white brown brown	orange white black black brown
1	330Ω	orange orange brown brown	orange orange black black brown
1	270Ω	red violet brown brown	red violet black black brown
1	220Ω	red red brown brown	red red black black brown
1	120Ω	brown red brown brown	brown red black black brown
6	100Ω	brown black brown brown	brown black black black brown
3	68Ω	blue grey black brown	blue grey black gold brown
1	10Ω	brown black black brown	brown black black gold brown
1	6.8Ω	blue grey gold brown	blue grey black silver brown
4	0.1Ω	brown black silver brown	black brown black silver brown
2	0Ω	single black stripe	single black stripe

Fig.11: follow this diagram if you are using BF469 & BF470 transistors. They go on the inside of the heatsink and require an insulating washer.

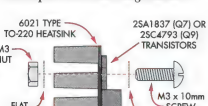


Fig.12: the alternative 2SA1837 (Q7 and 2SC4793 (Q9) transistors are attached to the outside of the heatsinks & do not require insulating washers.

RCA socket (CON1) and power input connector (CON2). The vertical RCA socket (if used) goes in a different position than the horizontal one, ie, it uses the pads to the left (see photo).

Follow with the 220nF and 470nF metal film capacitors, then fit trimpot VR1 with its adjustment screw towards the bottom as shown. The 47μF and 470μF electrolytic capacitors can then go in. The 47μF NP (non-polarised) electrolytic can go in either way around but the others must all be orientated correctly.

Don't install the 1000μF capacitors yet. These parts are left out until after the assembly is fitted to the heatsink, otherwise you won't be able to tighten the mounting screws for Q10 & Q11.

Flag heatsinks

Before fitting Q7 and Q9, you must first attach their flag heatsinks. If you are using BF470 (Q7) and BF469 (Q9) transistors, these should be attached to their heatsinks as shown in Fig.11. Alternatively, if using 2SA1837 (Q7) & 2SC4793 (Q9) transistors, fit the heatsinks as shown in Fig.12.

Note that you must use insulating washers with the BF469/BF470 transistors. The 2SA1837 & 2SC4793 types have insulated tabs, so no washers are required.

Do the mounting screws up finger-tight initially, then push the transistor leads through the PCB so that the heatsinks line up with the indicated positions. If you are using BF469 & BF470 transistors, push each one down so that its heatsink sits flush against the PCB. That done, solder the leads and tighten the mounting screws.

It's best to lightly solder one lead of each transistor first, then make any necessary adjustments before soldering the other two leads. Make sure that the insulating washers are properly aligned before tightening the mounting screws and be careful not to get the two transistors mixed up.

The 2SA1837 & 2SC4793 transistors have their base and emitter leads transposed compared to the BF470/BF469 types and so are mounted on the back of each heatsink (see Fig.12). Once they are attached, its just a matter of fitting them to the outside sets of pads so that the heatsinks are in the correct locations. Push the transistors down as far as they will go (in this case, the heatsinks will sit about 2mm proud of the PCB) before soldering their leads.

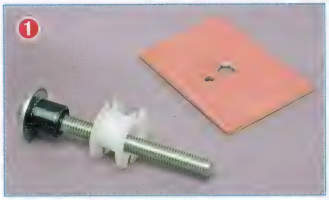
As before, take care not to get the two transistors mixed up.

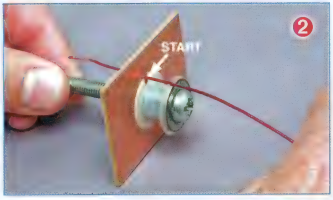
Note that the parts layout diagram (and the photo in Pt.1 last month) indicate the arrangement for BF470/BF469

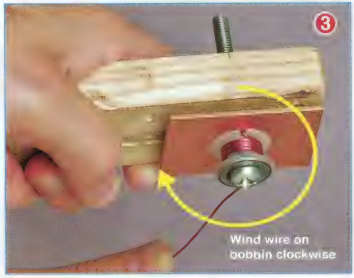
Table 2: Capacitor Codes

Value	μF Value	IEC Code	EIA Code
470nF	0.47μF	470n	474
220nF	0.22μF	220n	224
100nF	0.1μF	100n	104
4.7nF	.0047μF	4n7	472
180pF	NA	180p	181

Making A Winding Jig For The 10µH Inductor







These photos show how the winding jig is used to make the 10µH inductor. First, the bobbin is slipped over the collar on the bolt (1), then an end cheek is attached and the wire threaded through the exit slot (2). The handle is then attached and the coil tightly wound onto the bobbin using 30.5 turns of 1mm-diameter enamelled copper wire (3). The finished coil (4) is secured using a couple of layers of insulation tape and a band of heatshrink tubing.

The winding jig consists of an M5 x 70mm bolt, two M5 nuts, an M5 flat washer, a piece of scrap PC board material (40 x 50mm approx.) and a scrap piece of timber (140 x 45 x 20mm approx.) for the handle.

In use, the flat washer goes against the head of the bolt, after which a collar is fitted over the bolt to take the bobbin. This collar should have a width that's slightly less than the width (height) of the bobbin and can be wound on using insulation tape.

Wind on sufficient tape so that the bobbin fits snugly over this collar without being too tight.

Next, drill a 5mm hole through the centre of the scrap PC board material, followed by a 1.5mm exit hole about 8mm away that will align with one of the slots in the bobbin. The bobbin can be slipped over the collar, after which the scrap PC board "end cheek" is slipped over the bolt (ie, the bobbin is sandwiched into position between the washer and the scrap PC board).

Align the bobbin so that one of its slots lines up with the exit hole in the end cheek, then install the first nut and secure it tightly. The handle can then be fitted by drilling a 5mm hole through one end, then slipping it over the bolt and installing the second nut.

transistors. The photos published this month show 2SA1837/2SC4793 transistors in position.

Winding the inductor

The inductor (L1) is wound using a 2-metre length of 1mm-diameter enamelled copper wire on a plastic bobbin. Use a winding jig, as shown in the above panel; without it, it's a much more difficult procedure and you risk damaging the relatively fragile bobbin.

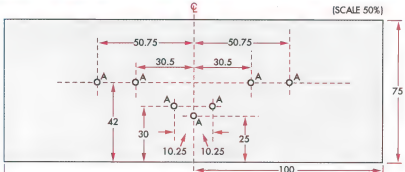
Attach the bobbin to the jig as shown, then wind on 30.5 turns of 1mm diameter wire in the direction indicated (ie, clockwise), leaving about 20mm-long leads at each end.

When finished, secure the winding with a narrow strip of insulation tape, then slip a 10mm length of 20mm-diameter heatshrink tubing over the bobbin and heat it gently (be careful not to melt the bobbin). That done, use a small, sharp hobby knife to scrape away the enamel from the protruding lengths of wire (around the whole circumference) and then tin them. The inductor can then be installed on the PCB, orientated as shown.

Preparing the heatsink

The next step is to drill and tap the heatsink – see Fig.13 and the accompanying panel. This is the most painstaking part of the assembly process and it's worth taking your time with it.

Drilling & Tapping The Aluminium Heatsink



HOLES A: DRILL 3mm DIAMETER OR DRILL 2.5mm DIAMETER & TAP FOR M3 SCREW. DEBURR ALL HOLES.

Fig.13: this half-size diagram shows the heatsink drilling details. The holes can either be drilled and tapped (using an M3 tap) or can be drilled to 3mm and the transistors mounted using machine screws, nuts & washers.

Fig.13 above shows the heatsink drilling details. If tapping the holes, they should be drilled to 2.5mm diameter **right through the heatsink plate** and then tapped to 3mm. Alternatively, the holes can be drilled through using a 3mm drill and the transistors mounted using screws, nuts and washers.

It's somewhat more work to tap the holes but it makes mounting the transistors quite a bit easier (no nuts required) and gives a neater appearance.

Before drilling the heatsink, you will have to carefully mark out the hole locations using a very sharp pencil. **That done, use a small hand-drill fitted with a 1mm bit to start the location of each hole.** This is important as it will allow you to accurately position the holes (the locations are critical) before stepping up to larger drills in a drill press.

Be sure to use a drill press to drill the holes (there's no way you'll get the holes perfectly perpendicular to the mounting face without one). Use a small pilot drill to begin with (eg, 1.5mm), then carefully step up the drill size to either 2.5mm or 3mm. The holes have to go between the fins so it's vital to accurately position them. In addition, you can drill (and tap) three holes in the base of the heatsink so that it can later be bolted to a chassis.

Be sure to use a suitable lubricant when drilling the holes. Kerosene is the recommended lubricant for aluminium but we found that light machine oil (eg, Singer or 3-in-1) also works well for jobs like this.

Don't try drilling the holes in one go. **When drilling aluminium, it's important to regularly remove the bit from the hole and clear away the metal swarf.** If you don't do this, the aluminium swarf has a nasty habit of jamming the drill bit and breaking it. Re-lubricate the hole and the bit with oil each time before you resume drilling.

Tapping

To tap the holes, you will need an M3 intermediate (or starting) tap (not a finishing tap). The trick here is to take it nice and slowly. **Keep the lubricant up and regularly wind the tap out to clear the metal swarf from the hole. Re-lubricate the tap each time before resuming.**

Do not at any stage apply undue force to the tap. It's all too easy to break a tap in half if you are heavy-handed and if the break occurs at or below the heatsink's face, you can scratch both the tap and the heatsink (and about $25). Similarly, if you encounter any resistance when undoing the tap from the heatsink, gently rotate it back and forth and let it cut its way back out. In short, don't force it or it will break.

Having completed the tapping, deburr all holes using an oversize drill to remove any metal swarf from the mounting surface. The mounting surface must be perfectly smooth to prevent punch-through of the transistor insulating washers.

Finally, the heatsink should be thoroughly scrubbed cleaned using water and detergent and allowed to dry.

Ideally, the transistor mounting holes should be tapped with an M3 thread. If you don't want to (or can't) tap the holes, you can simply drill 3mm holes instead. In this case, accuracy is of the utmost importance as it's difficult to fit the screws if the holes aren't correctly positioned between the fins.

You also need to drill and/or tap the heatsink to mount it in the chassis. You can either drill and tap three holes in the bottom of the heatsink (see photo) or you can attach right-angle brackets to the sides or face.

Once all the holes are drilled, deburr them using an oversized drill bit and clean off any aluminium particles or swarf. Check that the area around the holes is perfectly smooth or else the insulating washers could be damaged.

Final assembly

Now it's time to mate the PCB with the main heatsink but first re-check the face of the heatsink. All holes must be deburred and it must be perfectly clean and free of any grit or metal swarf.

Start the heatsink assembly by mounting transistors Q10, Q11 & Q16. A silicone rubber washer goes between each of these transistors and the heatsink. Q10 and Q11 also require an insulating bush under each screw head. Fig.14 (A & B) shows the mounting arrangements.

Because these three transistors are so close, you may need to trim the sides of Q16's washer so they fit side-by-side. Be careful not to get Q10 & Q11 mixed up as their type numbers are similar.

If the holes are tapped, these transistors can be secured using M3 x 10mm machine screws. Alternatively, if you have drilled non-tapped holes, you will need to use M3 x 15mm machine screws, with the screws coming through from the heatsink side (ie, the screw heads go between the heatsink fins).

Make sure the three transistors and their insulators are properly vertical, then do the screws all the way up but don't tighten them yet; ie, you should still just be able to rotate the transistors in each direction.

The next step is to fit an M3 x 10mm tapped spacer to each corner mounting hole on the PCB. Secure these using M3 x 6mm machine screws. Once they're on, sit the board down on the spacers and lower the heatsink so that

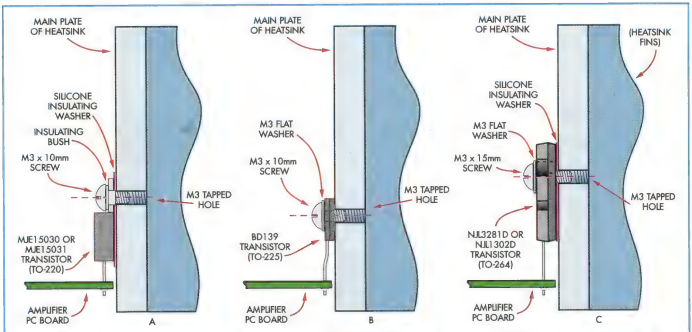


Fig.14: this diagram shows the mounting details for the TO-220 driver transistors (A), the BD139 V_{BE} multiplier (B) and the four output transistors (C). After mounting these transistors, use your multimeter (switched to a low ohms range) to confirm that they are properly isolated from the heatsink – see text.

the transistor leads pass through the appropriate holes.

The four output transistors (Q12-Q15) can now be fitted. Two different types are used so be careful not to mix them up (check the layout diagram). As shown in Fig.14(C), these devices must also be insulated from the heatsink using silicone insulating washers.

Start by fitting Q12. The procedure here is to first push its leads into the PC mounting holes, then lean the device back and partially feed through an M3 x 15mm mounting screw with a flat washer (or M3 x 20mm for untapped holes). That done, hang the insulating washer off the end of the screw and then loosely screw the assembly to the heatsink.

The remaining three devices are then installed in exactly the same way but take care to fit the correct transistor type at each location. Once they're in, push the board down so that all four spacers (and the heatsink) are in contact with the benchtop. This automatically adjusts the transistor lead lengths and ensures that the bottom of the board sits exactly 10mm above the bottom edge of the heatsink.

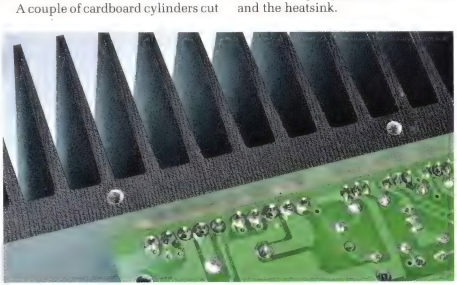
Now adjust the PCB assembly horizontally so that each side is 32.5mm in from its adjacent heatsink end. Once you are sure it is properly positioned, tighten all the transistor screws just enough so that they are held in place while keeping the insulating washers correctly aligned.

The next step is to lightly solder the outside leads of Q12 & Q15 to their pads on the top of the board. The assembly is then turned upside down so that the heatsink transistor leads can be soldered.

Before soldering the leads though, it's important to prop the front edge of the board up so that the PCB is at right-angles to the heatsink. If you don't do this, it will sag under its own weight and will remain in this condition after the leads have been soldered.

A couple of cardboard cylinders cut to 63mm can be used as supports (eg, one at each corner adjacent to CON1 & CON3). With these in place, check that the board is correctly centred on the heatsink, then solder all 29 leads. Make sure the joints are good since some can carry many amps at full power.

Once the soldering is completed, trim the leads using a steel rule as a straight edge to ensure consistent lead lengths. That done, turn the board right way up again and tighten the transistor mounting screws to ensure good thermal coupling between the devices and the heatsink.



Three M3 (or M4) holes can be drilled and tapped in the base of the heatsink so that it can later be attached to a chassis. These should be about 10mm deep.

Music Power, Dynamic Headroom & Slew Rate

WHILE WE PUBLISHED comprehensive performance data and graphs on the Ultra-LD Mk.3 in last month's article, we did not include figures for music power, dynamic headroom or slew rate limit. These are less indicative of raw performance than the figures already published but readers have asked for them so here they are.

The power output specifications presented last month are for continuous sine-wave output. But this is quite a rigorous test which is far removed from normal signals involving music, speech and sound effects which usually have a peak power to average power ratio of at least 10dB. For classical music, the ratio is usually at least 20dB.

So for a more realistic indication of how much power is available with music signals, we can apply a sinewave burst signal with a specific dynamic range and measure the peak power delivered before clipping or serious distortion. With the right signal characteristics, this gives us a "music power" rating. The ratio of music power to maximum continuous power is the "dynamic headroom".

The standard (IHF-A-202/EIA RS-490) specifies the test signal as a 1kHz sine-wave which alternates between full scale (0dB) for 20ms and -20dB (ie, 1/10th the voltage) for 480ms. Fig.15 shows a digital scope grab of this test being run into an 8Ω load (the green input trace is hidden under the yellow output trace as they track very closely).

The reason that the music power rating is higher than the continuous power rating has to do with supply regulation, which is mainly determined by the power transformer and bridge rectifier diodes. By "regulation" we mean how much the supply voltage changes depending on the current drawn from it. Because the music power tests involve a lower average current, the transformer isn't loaded as heavily and so the supply voltages don't sag as much.

The dynamic headroom for this amplifier is a healthy 2dB for 8Ω loads and 2.6dB for 4Ω loads. You can verify the 8Ω music power rating with Fig.15 by converting the peak voltage to RMS and using the formula $P = V^2 \div R$.

Slew rate

We are sometimes asked what the slew rate is for our amplifier designs. Slew rate is often touted in some hifi magazines as being important for "fast" audio amplifiers. It is really a lot of rot as slew rate is primarily a relevant figure for video amplifiers but we've measured it anyway and we will describe its significance. It's measured by applying a square-wave signal with very fast rise and fall times; much faster than occur in any normal audio signals.

Fig.16 shows the unloaded square-wave response of the Ultra-LD Mk.3 module. The input signal (after the RF filter) is in cyan and the output in yellow. For this test, the square-wave generator must have a low output impedance (<100Ω) otherwise the RF filter limits the slew rate more than the amplifier.

As typical for an audio amplifier, the transient response shows some overshoot (about 20%). Since audio signals do not have such fast transitions (ie, no frequencies above about 20kHz), it isn't a problem.

To accurately measure the slew rate, we put the amplifier on-load and zoomed in on the rising and falling edges. For an 8Ω load, the voltage ramps 12V over a 500ns interval, so the slew rate is 24V/µs (with a load, it's the same for both directions). With a 4Ω load, it drops slightly, to 20V/µs.

The maximum slope of a sinewave is computed (in V/s) as **2π x frequency x peak voltage**. So to obtain a full-scale (55V peak) 20kHz sinewave output we need a slew rate of 2π x 20,000 x 55 ÷ 1,000,000 = 6.9V/µs. So the slew rate of this amplifier (24V/µs) is far more than adequate.

Additional Specifications

Music Power	170W (8Ω), 270W (4Ω)
Dynamic Headroom	2dB (8Ω), 2.6dB (4Ω)
Slew Rate	+35,-60V/µs (no load), ±24V/µs (8Ω), ±20V/µs (4Ω)

Don't over-tighten the mounting screws though. Remember that the heatsink is made from aluminium, so you could strip the threads if you are too ham-fisted.

Checking device isolation

You must now check that the transistors are all electrically isolated from the heatsink. That's done by switching your multimeter to a high ohms range and checking for shorts between the heatsink mounting surface and the collectors of the heatsink transistors (note: the collector of each device is connected to its metal face or tab).

For transistors Q10-Q15, it's simply a matter of checking between each of the fuse-clips closest to the heatsink and the heatsink itself (ie, on each side of the amplifier). That's because the device collectors in each half of the output stage are connected together and run to their respective fuses.

Transistor Q16 (the V_{BE} multiplier) is different. In this case, you have to check for shorts between its centre (collector) lead and the heatsink.

In either case, you should get an open-circuit reading. If you do find a short, undo each transistor mounting screw in turn until the short disappears. It's then simply a matter of locating the cause of the problem and remounting the offending transistor.

This power supply board can run two Ultra-LD Mk.3 amplifier modules and will be described in Pt.3 next month.

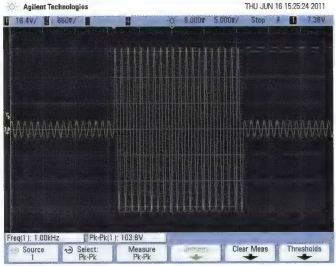


Fig.15: this shows the pulsed sinewave that's used to test the amplifier's music power (-20dB for all but 20ms every 500ms). The yellow trace is the output while and green trace (underneath it) is the input signal. The level is set as high as possible without the output clipping during the high amplitude burst. The music power can then be calculated based on the peak output voltage, in this case 170W (8Ω).

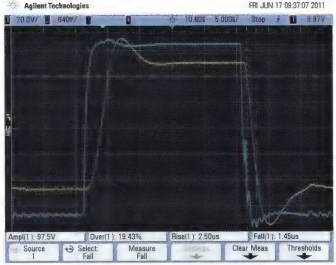
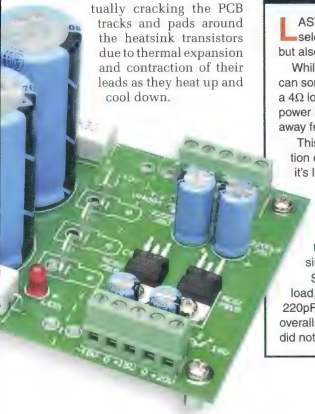


Fig.16: the slew rate test waveform. The cyan square wave is the input signal (somewhat distorted by circuit capacitances and parasitic inductance). The yellow waveform is the amplifier's output. As can be seen, its edges are less vertical than the input signal and by measuring their slope we can calculate the amplifier's maximum slew rate. 20% overshoot is typical for an audio-optimised amplifier.

Be sure to replace the insulating washer if it has been damaged in any way (eg, punched through).

Completing the PCB assembly

The PCB assembly can now be completed by installing the two 1000µF 63V capacitors. You must also remove the two support spacers from the edge of the board adjacent to the heatsink. In fact, it's quite important that the rear edge of the board be supported only by the heatsink transistor leads. This avoids the risk of eventually cracking the PCB tracks and pads around the heatsink transistors due to thermal expansion and contraction of their leads as they heat up and cool down.



In short, the rear spacers are installed only while you fit the heatsink transistors and must then be removed. They play no part in securing the module. Instead, this edge of the module is secured by bolting the heatsink itself to the chassis.

As previously stated, this can be done by tapping M3 (or M4) holes into the main plate on the underside of the heatsink or by using right-angle brackets. The front of the board is secured using the two M3 x 10mm spacers fitted earlier.

That completes the assembly of the power amplifier module. The next step is to build the power supply module and we'll describe how that's done next month. We'll also describe how to power up and test the amplifier and give some basic details on housing it in a metal case. SC

Stability At Very High Power

LAST MONTH, we explained how the 180pF compensation capacitor values are selected to not only prevent the amplifier from oscillating under normal conditions but also during recovery after being driven into clipping.

While this is true for a continuous sinewave, we discovered that the Ultra-LD modules can sometimes "misbehave" in response to very large but brief signal excursions with a 4Ω load (this can be observed with peak power levels in the range of 300W). At this power level, occasionally we can observe an output deviation as the signal swings away from the negative rail.

This is nothing like the high-frequency oscillation that can occur if the compensation capacitors are undersized; it certainly won't blow the fuses and we don't think it's likely to cause transistor or speaker damage. But it does result in a temporary, massive increase in distortion. Mind you, driving any amplifier beyond clipping also causes a massive increase in distortion!

The reason for this behaviour seems to be that the power supply is sagging badly under such a load and this causes a small amount of clipping during the latter portion of the signal peak. This is based on the fact that for a 20-cycle sinewave burst, typically only one of the cycles will be distorted.

So if you plan to drive the Ultra-LD Mk.3 amplifier right at its power limit into a 4Ω load, it may be worthwhile increasing the compensation capacitors from 180pF to 220pF (Rockby stock code 31943). This will slightly worsen the distortion performance overall but should allow 4Ω peak power in excess of 300W without this problem. We did not observe this phenomenon when driving an 8Ω load.

One-Stop August Deals

G-Sensor triggers recording under heavy braking!

NEW!
$399
S 9431

Dual Camera GPS Vehicle Recorder

Records footage inside & outside the vehicle simultaneously to the internal 8GB micro SD card. Essential when analysing workplace accidents, malicious damage and driver assaults etc. All audio & video is synchronised with GPS co-ordinate readings & Google maps. Low light CMOS sensor designed for night and day time operation. Four infrared LEDs illuminate the cars interior at night. To review footage, simply connect via USB and load up the included PC software.
Size: 115W x 57D x 24Hmm

OPEN IN SEPTEMBER!

NEW! One-Stop Electronics Shop at
Unit 7, 58 Erindale Rd, Balcatta, WA.
Visit our website during August for opening date.

X 4003
SAVE 20%
$55

Latest model

Monitor your circulation health at home!

Measures systolic, diastolic pressures & heart rate: Provides a simple way to get fast and accurate blood pressure readings. Stores 40 readings for up to 3 individuals. Includes 4 x AAA batteries & carry case.

X 0198
SAVE 15%
$10

Compact 4 LED Headband Torch

- 3 white LED • 1 red LED • 3 modes - white light, red light or flashing red • Requires just one AA battery.
- So light, you'll barely know you're wearing it!

$99 NOW ONLY!
T 2416

The T 2443 replacement has landed!

Micron® 45W Digital Soldering Station

An excellent multi purpose soldering iron for service technicians, schools, engineers, R&D, production work etc. Japanese ceramic element for long life. 150° to 480°C. 0.8mm tip. **May be used with mini-wave tips, see below.**

Suits lead free soldering | Burn proof rubber lead | All metal case

High power 70W model!

X 0109
SAVE $20
$139

Professional Ultrasonic Cleaner

Suitable for delicate items such as jewellery, spectacles or car parts. Uses water and household detergent, coupled with ultrasonic waves to clean even the tiniest of items without damage. Features a 137 x 170 x 58mm stainless steel tank and a 1.5 to 8 min timer. 240V operation.

Netbook Power Supply

Ideal replacement for lost/broken supplies. Fitted with USB output. Includes 6 tips & mains lead. 12-20VDC, max 6A/75W.

SAVE 22%
$45
M 8992

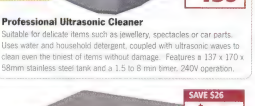
Mini-Wave Soldering Tips

These fine concave tips allow hand flow soldering of surface mount devices such as chip caps, resistors, SOIC & PLCC packages.
Suits T 2416 & T 2418.

NEW!
$23.95ea

Great for SMD work!

1.0mm	T 2471
2.0mm	T 2472
3.0mm	T 2473



SAVE $26
$99

Records to USB.

A 2808

High Definition Digital TV For Your Car or Caravan!

12V set top box with remote control. • Keep the family entertained on holiday. • HDMI, component or composite outputs • Digital & stereo audio • Just 115mm wide.

Desktop Thermometer & Hygrometer

Great for greenhouses, home brew kits, cellars, computer rooms or just keeping an eye on the weather! **Features:** • 0 to 50°C • In & outdoor temperatures plus humidity • Min, max and hold functions • Clock

SAVE 24%
$15
A 0152

Desktop Hard Drive Dock

The easy way to move data from one drive to another. Suits 2.5" or 3.5" SATA hard drives. Enables fast 'hot swapping' of drives whilst the PC is on. A must for IT technicians! USB2.0 or eSATA. Two USB ports on front panel. Includes power supply. *Hard drive not included.

SAVE 13%
$45
D 5506

Get all your alarm accessories at Altronics!

SAVE $30
$169
S 5268

Protect Your Home & Family Today!

8 Zone Alarm System For Home Or Business
A quality professional alarm system at an affordable price. Can be fully installed and programmed by YOU in just hours - save a fortune! Includes control box and keypad. Includes comprehensive instructions making your install easy.

16V AC Plugpack	M 9332A	$26.95
Extra keypads (max 4)	S 5269	$59

USB Microscope Camera: View Up To 200x Closer!

Boasting a high 200x magnification and 2 megapixel sensor, this microscope is great for electronic inspection or as an educational or visual aid (reads fine print with ease!). Provides a live motion, view via its inbuilt camera, plus still shot function. LED illumination ensures you always get a clear, crisp view. Focuses down to 5 centimetres!

SAVE $10
$90
X 4300A

WINDOWS 7, OS X compatible. Windows Vista & XP also works.

Dynalink® 4 Way HDMI Switcher

With IR remote control. Designed to switch between four HD sources. • Compact design, only 192W x 98D x 25Hmm. • Up to 1080p resolution • Includes plugpack • HDCP compliant.

A 3081A
SAVE 22%
$69

ALTRONICS
ONE-STOP ELECTRONICS SHOP

3 Electronics Enthusiast Centres:

Perth WA: 174 Roe St
Auburn NSW: 15 Short St
Springvale VIC: 891 Princes Hwy

Handy Power Products...

SAVE $54
$235
M 8205

Precision Benchtop Lab Power Supply
Fully adjustable with LCD meters for precision adjustments. Great for R&D, workshops or repair centres etc. • Separate controls for voltage & current • Fixed 12V & 5V output rails • 0-30V, 0-5A adjustable • Fully regulated • Short circuit & overload protection.

SAVE 15%
$42

3 Channel Energy Meter
This wireless home energy monitor can log power usage on up to 3 mains outlets around the house. Includes channel 1 plug in sensor & base station. 30m range. Displays usage in kW/h or currency. **P 8137**

Channel 2 Transmitter	P 8138	$24.95
Channel 3 Transmitter	P 8139	$24.95

A 0283
SAVE 25%
$22
Includes: Mains plugpack | Car adaptor

NiMH 2 Hour Battery Charger
Use it at home or on the road! Charge 4 x AA or AAA batteries in just 2 hours. LCD readout provides bargraph charge status. Note: Not suitable for use with low-discharge NiMH batteries (S 4704/8).

M 8070
SAVE 20%
$39
Modified sine wave

240V Power From Your Drink Holder!
Provides 240V power for charging laptops, small tools, lamps, chargers and more! 150W rated (450W surge). Ideal for camping. Host of protection features. Soft start & high/low voltage shutdown. 12V input, 60mmØ.

M 8996
LOW PRICE!
$74.95

100W Laptop Notebook Power Supply
Ideal replacement for lost/broken laptop supplies. Fitted with dual USB outputs for powering peripherals. Includes 8 tips to suit most laptops. Selectable voltages (15-24VDC), max 6A. Includes mains lead.

SAVE 20%
$44
M 8627A

Charge Your Laptop In The Car
This compact supply simply plugs into a car accessory socket & provides regulated power to a laptop. Selectable voltages: 15, 16, 18, 19, 20, 22 and 24VDC, up to 120W. Supplied with 8 adaptors to suit most laptops.

SAVE 22%
$17/pk
S 4746F 4pk AA

SAVE 28%
$5/pk
S 4742D 2pk AAA

Quality NiMH Rechargeables
Recharge up to 1000 times, pay for themselves in just a few uses!

M 9449A
SAVE 22%
$19
Super slimline case!

Multivoltage Plugpack.
Always handy to have around, this tiny plugpack powers devices on 3, 4.5, 5, 6, 7.5, 9 & 12V up to 600mA.

SAVE 15%
$55
Great for small remote power systems
N 0704

Compact 5W Solar Power Module
Features an amorphous 5W module protected behind tempered glass. 400mA output current, ideal for charging a 12V SLA battery. 32x47cm.

M 8162
SAVE 20%
$47

Power 12V Devices From A 24V Battery System!
Quick and easy conversion from 24V to 13.8V DC. Ideal for reducing a 24V solar system output to 12V DC for low voltage lighting etc. Includes overload, overcurrent protection & fused outputs. 8A continuous, 10A max.

SAVE 27%
4 For
$26
S 4750A

Sub-C NiMH Tag Batteries
With connection tabs. Ideal for replacing dead cells in power tool battery packs. 3300mAh.

A 0340
SAVE 22%
$13
Save power around the house

Switch Appliances On & Off By Remote Control
Up to 20m range! Control up to 5 mains sockets from one remote, allowing ON/OFF switching for up to 1000W of appliances per socket. Extra outlets A 0342 $11.95ea.

The Six Way Surge Stoppa!
Cheap insurance for your valuable appliances. 6 mains outlets plus telephone line surge protection. **P 8151**
SAVE 35%
2 For
$30

SAVE 15%
$5ea

Solderless DC Power Jacks
A real time saver for CCTV installs & projects. Screw terminal connection 2.1mm. **P 0608 Plug. P 0610 Socket.**

Power up 110V devices
M 8181 75VA
SAVE 20%
$39
M 8182 100VA
SAVE 20%
$60

Step Down Converters
Power 110-120V appliances from 240V mains power. Fitted with US mains socket.

Programmable Digital Timers
Versatile 7 day digital timers for use in DIY automation projects. 16A @ 30VDC contact rating. Easy to program with up to 8 ON/OFF switching periods per day.
S 0049 12VDC
S 0050 24VAC/DC
S 0051 240VAC

SAVE 18%
$40ea

N 2075
SAVE 19%
$32
N 2077
SAVE 20%
$30

Solar Charge Controllers
Suits wet or dry cell batteries. 6A charging current. **N 2075:** Operates as a solar battery charger by day. At night auto-dusk detection switches on the connected load. **N 2077:** Solar battery charger circuit only. No load switching.

P 0606
BARGAIN!
$4.95

Easy Power Termination
Lights up a LED to indicate polarity, AC or DC input. Blue for tip positive, red for tip negative, purple for AC. 5-30V AC/DC input. 800mm fly lead.

Top Test Gear Deals

Q 0203

NEW!

$1149

Ultra compact. 75% smaller than the old CRT versions!

Specifications	
Bandwidth	100MHz
Sample Rate	1GSa/s or 500MSa/s
Auto measure	32 parameters
Math functions	+, -, multiply, FFT
Ports	USB & RS-232C
Display	7" TFT 480x230px
Dimensions	399Wx149Hx110D
Weight	2.4kg

Atten* 100MHz R&D Digital Storage Oscilloscope

Perfect for those in R&D, product development or service of complex electronic equipment. Features 2 channels with real-time sampling modes of 500MS/s or 1GSa/s. The 64K colour 7" TFT display screen can be set up to simultaneously display the waveform plus indicate the measured wave voltage, peak to peak plus RMS, frequency, duty cycle etc. Using the USB lead and software supplied realtime adjustments can be made of the scope. Any stored data or settings can be either saved to a USB stick or downloaded to a PC. If connected to a PictBridge™ printer, screenshots can be printed without a PC.

Multimeters Galore - SAVE 20%

SAVE 22%

$70

Q 1079

USB Autoranging Datalogger & Software

A complete datalogging multimeter, plus software suite allowing analysis of circuit operation over time. **Features:**

• Autoranging with override • Bargraph readout • Data hold & relative modes • Duty cycle % • Optical isolation • AC/DC current to 10A • Includes software, test leads, temp probe & shock proof rubber coated case • Suits Windows XP & Vista

SAVE 22%

$155

Q 1536

Professional 2.7GHz Frequency Counter

High accuracy counter covering a range of 10Hz to 2.7GHz in two ranges; 10Hz to 100MHz and 100MHz to 2.7GHz. Ideal for servicing and calibrating RF equipment, radio mics, CB's & transceivers. High input sensitivity. Period, frequency, pulse count (totalise) functions. x20 input

Q 1067

SAVE 20%

$55

Jumbo Display 28 Range DMM

Includes temperature probe at no extra cost! Excellent for the service technicians or enthusiast.

• Massive 20A rating • AC/DC to 1000V • Auto power off • Temperature • Frequency • Data hold

Q 1133

SAVE 25%

$22

Micron* Autoranging Digital Multimeter

Simplicity & functionality in one compact test device. Jumbo easy read screen. 10A DC current. 1Hz-30MHz counter. Includes test leads & temperature probe. Great for students!

SAVE 12%

$160

Q 1286

Professional 'Contact Free' Digital Thermometer

With twin laser guided beam for pin point accuracy! Lightweight, "point and shoot" temperature measurement. Provides accurate temperature readings from ∎ distance. Ideal for measurement in dangerous places, or when equipment is operating. Incredible accuracy from -50°C to 1000°C. 30:1 optical resolution. 150ms response. 1% accuracy.

Test Wiring Polarity & Continuity In A FLASH!

Allows a single user to quickly identify two wires, even when the wire ends are located in different rooms. Makes testing a breeze, even on long cable runs and wiring harnesses. Includes 9V battery.

SAVE 40%

$24

Q 2024A

Top value for installers!

SAVE 25%

$44

Q 1270

Great for lighting & CCTV installation

Measure Light Levels Instantly!

Checking light levels is an essential part of selecting the right CCTV camera. High precision sensor provides instant, accurate lux readings. Includes protective case.

Precision Impedance Meter

Measures transformer & speaker impedance accurately and easily. Applies a test tone to any speaker or transformer circuit. Suitable for both 4-8 ohm & 100V line systems. Requires 6 x AA batteries.

SAVE $50

$199

Q 2005

Top Value!

Q 0964

SAVE 28%

$50

AC Clamp & Digital Multimeter Combo

Slimline design combines both digital multimeter and an 400A AC clampmeter into one unit. Superb ease of use makes it perfect for working on live equipment. An essential for high voltage technicians, electrical trades etc. **Features:**

• Capacitance • Temperature • Resistance • 400A AC • DC V to 600V

AC & DC Testing!

Q 0966

SAVE $30

$99

600A True RMS AC/DC Clamp Meter

Accurately measures AC or DC current to a MASSIVE 600A! A professional unit with advanced features such as true RMS AC measurement, resistance, temperature, capacitance, zero & hold functions - All supplied with carry case & test leads. Max input 600V.

Q 3002

SAVE 24%

$15

Precision Digital Pocket Scales

Great for measuring and counting lightweight items. Measures in grams, ounces, troy ounces & pennyweight. 0.1g resolution. 500g max. Includes tough plastic cover.

T 2260

SAVE 22%

$40

Detect Lethal AC Voltages Without Contact

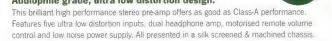
Non-contact AC detector with LED light. Essential for working with AC wiring. Lights up when near any AC source (100-600V @ 50-60Hz). Fits right in your pocket.

ALTRONICS
ONE-STOP ELECTRONICS SHOP

3 Electronics Enthusiast Centres:

Perth WA: 174 Roe St
Auburn NSW: 15 Short St
Springvale VIC: 891 Princes Hwy

Projects To Build...



K 5500 **$259** SAVE $41

Silicon Chip Studio Series Pre-Amplifier

Audiophile grade, ultra low distortion design.

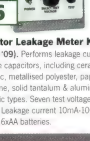
This brilliant high performance stereo pre-amp offers as good as Class-A performance. Features five ultra low distortion inputs, dual headphone amp, motorised remote volume control and low noise power supply. All presented in a silk screened & machined chassis. Every bit as good as a commercial unit, at a fraction of the cost! This full kit comprises of all PCB modules, chassis, transformer and all parts required for a complete unit!

VALUE! **$149**

K 6021

High Power Ultrasonic Cleaner Kit

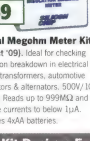
(SC August '10) Build this large, heavy-duty ultrasonic cleaner and blast away grime from virtually anything, using just water & a little household detergent. Sensor can be dunked into a bucket of water for cleaning large objects. Great for cleaning car parts & bric-a-brac.



K 2558 **$76** SAVE 10%

Capacitor Leakage Meter Kit

(SC Dec '09). Performs leakage current testing on capacitors, including ceramic, monolithic, metallised polyester, paper, polystyrene, solid tantalum & aluminium electrolytic types. Seven test voltages from 10-100V. Leakage current 10mA-100nA. Requires 6AA batteries.



K 2556 **$69** SAVE 12%

Digital Megohm Meter Kit

(SC Oct '09). Ideal for checking insulation breakdown in electrical wiring, transformers, automotive generators & alternators. 500V/1000V ranges. Reads up to 999MΩ and leakage currents to below 1µA. Requires 4xAA batteries.

$40 SAVE 20%

K 1095

Re-assembles into a new machine in an hour!

3 In 1 All-Terrain Robot Kit

Great fun for the kids to build and play with! This single kit can be built (and re-built) three ways to create a forklift, all-terrain rover or gripping 'pick up' machine. Lifting capacity ~100g. Includes wired remote control.

More Great Kit Designs From Silicon Chip...

K 5547 **$33** SAVE 15%

Improve Your Hearing Without Expensive Aids!

(SC Sept '10) Hearing Loop Receiver Kit. Picks up signals from a hearing loop (or T-coil), found in PA systems at places of worship and function centres. It even works with home made hearing loops. Requires 9V battery (S 4971 $5.95).

K 2531 **$45** SAVE 10%

Ultra-Low Milliohm DMM Adaptor Kit

Measure 0 to 10Ω resistance - much lower than most standard multimeters! (SC Feb '10). Plugs into any DMM! Low resistance measurement is ideal for matching resistors in amplifier output stages. Requires 9V battery.

K 4065 **$129** SAVE $20

Take The Guess Work Out Of Fixing Your Car!

(SC Feb '10). This car interpreter kit connects to your laptop and provides real time readouts from a multitude of engine sensors (in vehicles fitted with OBD II port). Ideal for mechanics & car enthusiasts. May require a RS232 to USB converter, D 2340B $29.95.

K 1681 **$25** SAVE 13%

Efficient Car/Motorbike USB Charger Kit

(SC May '10) Compact charging module for MP3 players, GPS devices & game consoles. • 89% efficiency • Very low quiescent current will not flatten your battery • 12V input, 5V 525mA output.

K 5174 Toslink to S/PDIF
K 5175 S/PDIF to Toslink

$14.95 BARGAIN!

Toslink S/PDIF Converter Kits

(SC October '10) Got a coaxial output but only an optical input? Or the other way around? No problem! These converters are the solution. Requires 6-15V AC or 9-20V DC plugpack.

$119 SAVE $50

The ultimate model railway controller

K 6015

Rail Power Controller Kit

(SC Sep-Oct '08) A great value model railway controller offering remote control, pulse power for realistic low speed train movement, speed bargraph & adjustable braking inertia. 16-17V output up to 6A. A 1012 remote to suit $19.95. 240V operation.

Resellers:

WESTERN AUSTRALIA

Bunbury	ML Communications	9721 9800
Esperance	Esperance Communications	9071 3344
Geraldton	ML Communications	9965 7555

VICTORIA

Alexandra	Alexandra Air Con & Appliance Centre	5772 1147
Ballan	Radcomp	5368 1761
Beaconsfield	Electronic Connections	9768 9420
Benalla	North East Electronics	5762 2710
Castlemaine	Top End Technology	5472 1700
Clayton	Rockby Electronics	9562 8559
Cranbourne	Bourne Electronics	5996 2755
Croydon	Truscott's Electronic World	9723 3860
Geelong	Academy TV Australia	5246 2621
Geelong	Music Workshop	5221 5844
Healesville	Amazon DVDs Healesville	5962 2783
Leongatha	Gardner Electronics	5662 3891
Melton	Melton Electronics & Communications	9743 1233
Nunawading	Semtronics	9873 3555
Pakenham	Get Smart Hifi	5941 4886
Preston	Preston Electronics	9484 0191
San Remo	Shoreline Electrical Wholesalers	5678 5361
Somerville	AVGPC	5978 0007
Warrnambool	Koroit St Electronics	5561 5111
Wodonga	Exact Computers & Home Ent.	6056 5746

QUEENSLAND

Brisbane South	Deiseund	3397 8155
Brisbane North	Prime Electronics	3252 7466
Cairns	Pentacom	4032 1710
Concurry	Access Electronics	4742 2580
Dalby	Camera House	4662 3228
Gold Coast	Prime Electronics	5531 2599
Innisfail	Leading Edge Electronics	4061 6214
Longreach	Access Electronics	4658 0500
Maryborough	Leading Edge Electronics	4121 4559
Rockhampton North	Home Delivered Computers	4928 2555
Rockhampton South	Access Electronics	4922 1058
Toowoomba	Michael's Electronics	4632 9990
Townsville	Soltex	4771 4211

NEW SOUTH WALES

Brookvale	Brookvale Electrical Distributors	9938 4299
Carlingford	Carlingford Music Centre	9873 2333
Casanock	Leading Edge Electronics	4990 5971
Cobar	Cobar Electronics	6836 2962
Deniliquin	Wired Entertainment	5881 3555
Gloucester	Autotec Gloucester	6558 1600
Grafton	Downes Electronics	6642 1911
Griffith	Griffith Systems Plus	6964 5933
Gunnedah	Protronics	6742 2110
Lithgow	Leading Edge Electronics	6352 3333
Mudgee	Home & Office Electronics	6372 1822
Nth Richmond	CPT-Candle Power Technologies	4571 4699
Oak Flats	Oak Flats Electronics	4256 6120
Orange	Fordray Electronics	6362 9901
Penrith	Penrith Light and Sound	4733 3333
Port Macquarie	Fettel Communications Pty Ltd	6581 1341
Raymond Terrace	Leading Edge Electronics	4987 4909
Smithfield	Chantrelle	9609 7218
Tamworth	Bourke Street Electronics	6766 4664
Taree	Noeledge Systems Pty Ltd	6551 3622
Ulladulla	Leading Edge Electronics	4454 5588
Wagga Wagga	Wagga Car Radio & Hi-Fi Pty Ltd	6925 6111
Waterloo	Herkes Electrical Supplies	9319 3133
Wetherill Park	Techtron Electronics Pty Ltd	9604 9710
Windang	Mad Electronics	4297 7373
Wyong	CCRV - Pro Disc	4353 1100

SOUTH AUSTRALIA

Adelaide	Aztronics	8212 6212
Brighton	Force Electronics	8377 0512
Enfield	Aztronics	8349 6340
Findon	Force Electronics	8347 1188
Kadina	Wellsecured	8821 2300
Mt Barker	Force Electronics	8391 1133
Milton	Leading Edge Electronics	8682 4911
Port Augusta	Spencer Electronics	0407189343

TASMANIA

Hobart	Active Electronics	6231 0111
Launceston	Active Electronics	6334 7333

NORTHERN TERRITORY

Katherine	Leading Edge Electronics	8972 3907

NEW ZEALAND

Christchurch - Riccarton	Global PC	3 3434475
Christchurch - Shirley	Global PC	3 3543333

Sale Ends August 31st 2011

Altronics One-Stop Electronic Shops Phone 1300 797 007 Fax 1300 789 777

Mail Orders: ©/- P.O. Box 8350 Perth Business Centre, W.A. 6849

© Altronics 2011. E&OE. Prices stated herein are only valid for the current month or until stocks run out. All prices include GST and exclude freight and insurance. See latest catalogue for freight rates. All major credit cards accepted.

A Rudder Indicator For Power Boats, Pt.2

By NICHOLAS VINEN

Last month we introduced our Rudder Position Indicator, which uses a 433MHz wireless link to show the direction a power boat's rudder is pointing. This month we provide detailed instructions for building and testing both units as well as mounting the sensor unit in the boat.

AS EXPLAINED last month, the Rudder Position Indicator comprises two units. The sensor unit monitors the rudder and transmits changes in its orientation over a 433MHz wireless link. The display unit picks up these communications and illuminates its LEDs in response.

While the two circuits are different, they are both based on ATTiny861 microcontrollers so there are many similarities in layout. Hence the procedures for building the two lower (control) boards, which each have a micro, are essentially the same.

You can either build them in parallel or you can build one and then go back over the following instructions to assemble the other.

Control board assemblies

The sensor unit control board is coded 20107111 and the display unit control board is coded 20107113. Both boards are 98.5 x 68mm with corner cut-outs; see the overlay diagrams of Fig.7 and Fig.8, respectively.

First inspect the copper sides for any defects such as hairline cracks or under-etched areas; repair if necessary. If your boards lack corner cut-outs, use a hacksaw and file to shape them using the thin copper tracks as a guide.

Proceed by installing the three wire links which run along the bottom of each board, using 0.7mm diameter tinned copper wire. Run the links close to the board and as straight as possible since they pass near component leads.

Next fit all the resistors, checking each value with a digital multimeter before installing it (the colour codes can be hard to read). Remember that you may need to change the value of the 390Ω resistor depending on the intended supply voltage/battery type.

Note that, for the display unit, **this resistor should be installed slightly offset**, as shown in the photo on page 78, to leave enough room for the push-button switch to be fitted later.

That done, install the diodes. Both boards use a 1N5819 Schottky diode (black plastic body) and a 16V zener diode (large glass body). Make sure they are orientated as shown on the overlay diagram, ie, with the stripes towards the bottom of the board.

For the display unit, also fit the small 1N4148 diode with its stripe to the left and the 100µH axial inductor which looks a bit like a fat resistor. Bend its leads close to the body to fit the pads; its orientation is irrelevant.

Next, solder in the IC sockets, ensuring that the notches are orientated as shown on the overlay diagrams. There is one 20-pin socket for the sensor unit and 20-pin and 16-pin sockets for the display unit. You must use a regular 16-pin "dual wipe" socket for the 74LS145 IC, since the more expensive type has exposed pins that could short to the adjacent wire links.

Now install the transistors. There are two on the sensor unit board and three on the display unit board and there are several different types, so check the markings carefully before soldering each in place. Crank the leads out using small pliers so that they fit into the holes provided, with the flat faces orientated as shown.

Fit the regulators next; they look similar to the transistors. There is one 3V (or 3.3V) regulator for each board plus a 5V regulator on the display unit; don't get them mixed up. Use the same technique as for the transistors.

Follow with the small trimpot, one on each board, then the MKT capacitors, which are all the same value (100nF). **Note that the 100nF capacitor at bottom left of the display control board (Fig.8) must be mounted on its side** (see photo) to leave room for the power connector.

The fuse-clips go in next. Push them right down onto the PCB before soldering the pins and take care that the small retention tabs face towards the outside or you won't be able to fit the fuses properly.

Then mount the pin headers, including the 12-pin female header at the bottom of each board (CON3/CON8), a 4-pin female header on the sensor board for the transmitter module (not labelled) and a 4-pin male header on each board (JP1/JP2). If you don't have 12-way female headers, use side-cutters to snip a longer header at its 13th pin, then remove that pin. You can cut the 4-pin header from the same length.

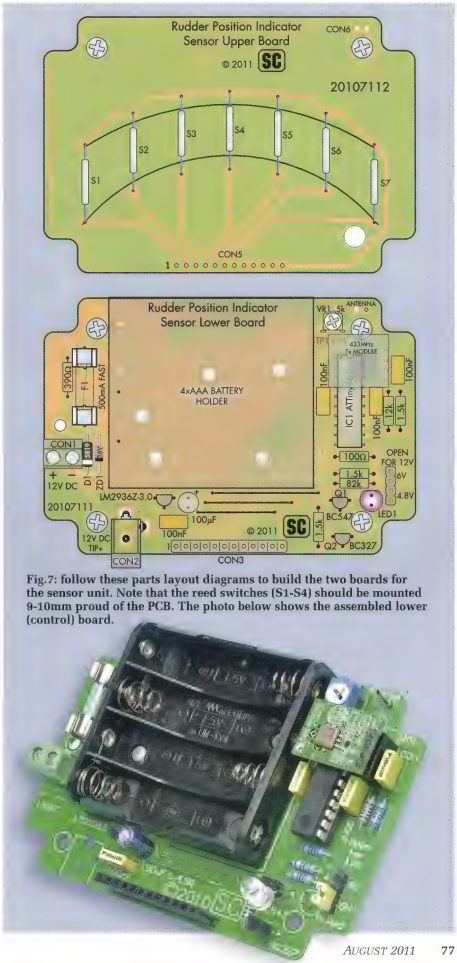


Fig.7: follow these parts layout diagrams to build the two boards for the sensor unit. Note that the reed switches (S1-S4) should be mounted 9-10mm proud of the PCB. The photo below shows the assembled lower (control) board.

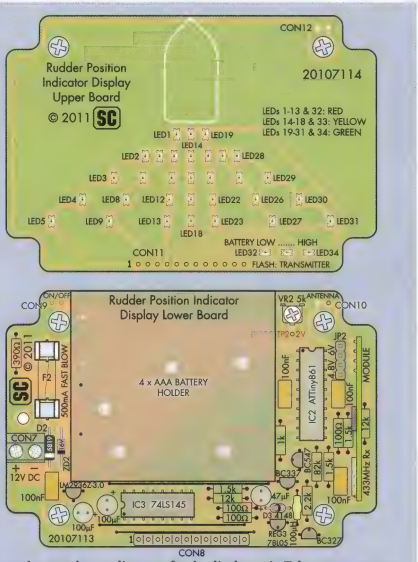


Fig.8: the parts layout diagrams for the display unit. Take care to ensure that the LEDs are all installed correctly – LEDs 1-31 all go in with the green dot on their body (indicating the cathode) at lower left, while LEDs 32-34 have the green dot at top left. Below is the fully-assembled lower (control) board.

Next, install two PCB pins on each board, one for the antenna where indicated and one test point (TP1/TP2). If you want a terminal block on either module for external power (or trickle charging the batteries), fit it now. The sensor unit control board also accepts an optional DC socket which can go in now.

The 4-AAA battery holder on each board goes in next. Push its leads through the corresponding pads and then secure it using two M2 screws inserted from inside the holder and fixed to the underside of the PCB using M2 nuts. Then solder and trim the leads. If you can only get M2 screws longer than 6mm you can cut them to size with a hacksaw or strong side-cutters but the end will need some filing before the nuts will thread.

Now fit the electrolytic capacitors. There is one 100µF capacitor for the sensor unit and two for the display unit, as well as one 47µF type for the latter. In each case, the longer lead goes through the hole marked "+" on the overlay diagram. Push them right down onto the PCB before soldering.

For the display unit, cut two 50mm lengths of light-duty hookup wire, strip and tin the ends and solder them to the CON9 pad at upper-left.

Modifying the transmitter

There isn't room to mount the 433MHz transmitter module vertically, using the attached right-angle pins. So they are removed and straight pins are installed instead which then plug into the 4-pin female header, so the transmitter module is parallel to the main PCB. The socket allows it to be unplugged to access the micro below.

Start by clamping one of the pins in an alligator clip stand or small vise, with the underside of the pin accessible. Then, using a fine-tipped soldering iron, very carefully heat that pad while gently lifting the module so that when the solder melts, the pin is removed. Repeat for the other three.

This must be done carefully as there are other pads and components very close to these and you don't want to accidentally create a short circuit with a blob of solder while removing the pins. When finished, clamp the module in a stand and use a solder sucker or vacuum de-soldering tool to clear the four holes.

Now temporarily install IC1 in its socket. Take the transmitter module

with the main IC at the top and push a straightened length of 0.7mm-diameter tinned copper wire through one of the newly-cleared holes. Lower the module down so that the wire goes into the appropriate hole on the 4-pin female header and push the wire down fully into place.

Now slide the transmitter module down so it's just above IC1, solder the wire in place and trim it. Repeat this process for the other three pins.

If you have trouble visualising how this works, refer to the photograph below Fig.7 to see the final result. When finished, remove the transmitter module and IC1.

The radio receiver module can simply be soldered into place on the display unit control board. Locate its antenna input (the pins are labelled on its PCB) and ensure that this pin is soldered to the pad closest to the antenna pad towards the top of the control board. Check that the receiver module is vertical and as close to the main board as possible before soldering all its pins.

LED board

The next job is to solder the SMD LEDs for the display unit, which go onto the board coded 20107114 (Fig.8). Check it for defects first and make the corner cut-outs, if necessary.

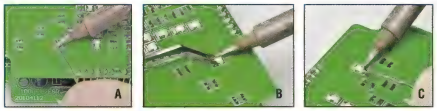
While the LEDs are quite small, they are not hard to solder. The hardest part is getting them all properly centred for a neat appearance.

The specified LEDs are 3.2 x 1.6mm (1206/3216 size) but the pads are also large enough for 3.2 x 2.4mm (1210/3224 size) LEDs, which may be available with higher power/brightness ratings.

Place the PCB down flat on a workbench, copper-side up and install the yellow LEDs first. There are six; five arranged vertically in the middle and one in the centre of the battery meter at lower-right. The procedure for soldering the LEDs is shown in the adjacent panel.

With them in place, fit the 14 red LEDs, with 13 on the left side of the rudder display and one at the lefthand end of the battery meter. The 14 green LEDs then go on the remaining pads.

If you make a mistake, such as installing a LED backwards, you can remove it by alternately heating its pads while grasping the LED body with tweezers and gently pulling up on it. Eventually it will lift off the board. Clean the excess solder off one of the pads using solder wick before reinstalling the LED.



Soldering the SMD LEDs

Install the LEDs one at a time, using the following steps:

STEP 1: melt some solder onto one of the two pads (A).

STEP 2: remove a LED from the packaging by carefully peeling back the clear plastic film. Identify the cathode end, marked with a small dot (probably green, regardless of LED colour).

STEP 3: pick up the LED by its sides, using angled tweezers.

STEP 4: place it near the pad where it is to be installed, **with the green dot towards the bottom or left side of the PCB** (as shown in the overlay diagram of Fig.8).

STEP 5: holding the soldering iron in one hand and the tweezers in the other, melt the solder you applied earlier while carefully sliding the LED in place along the PCB surface using the tweezers (B). Stop heating the solder when it is in place but wait a second or two to remove the tweezers, allowing the solder to cool and solidify.

STEP 6: if the LED isn't quite centred or straight, wait a few seconds, then re-heat the solder and gently move or rotate the LED using the tweezers. Repeat until it's properly centred.

STEP 7: apply solder to the other pad (C), ensuring that it flows fully onto the LED pin, which is on the end face of the "chip" that it sits on.

STEP 8: wait a couple of seconds for that solder to cool, then add a small amount of additional solder to the other pad, so that it re-flows, forming a neat joint. As you can see from the photos, with some care, it is possible to align the LEDs in neat rows.

Reed switches

The next job is to solder the seven reed switches to the sensor unit's upper board, coded 20107112. Check it for defects before proceeding and cut out the corners if necessary.

Bend the reed switch leads through 90°, 4mm from the glass capsule. This must be done very carefully since the

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	82kΩ	grey red orange brown	grey red black red brown
❑	3	12kΩ	brown red orange brown	brown red black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	6	1.5kΩ	brown green red brown	brown green black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	2	390Ω	orange white brown brown	orange white black black brown
❑	2	220Ω	red red brown brown	red red black black brown
❑	6	100Ω	brown black brown brown	brown black black black brown

These two photos show how the board assembles are stacked together on M3 x 15mm tapped Nylon spacers and secured using M3 x 20mm machine screws and nuts. The interconnections between the two boards in each assembly are made via 12-way pin headers. The sensor module is shown at top, with the display unit below it.

glass capsule is delicate, especially where the leads enter it. If any force is applied to the glass body via the leads, it can easily break.

The best approach is to clamp the leads with flat nose pliers, right where they exit the glass capsule and then bend the leads down, without touching the glass body at all.

To do this, we used Altronics T2770 stainless steel flat-nose pliers, with 4mm wide jaws. If you use narrower pliers, grab the lead slightly away from the capsule to bend them in the right place (ie, 4mm from where they exit the capsule).

Both leads must be bent in the same direction, making a "U" shape. We strongly recommend that you bend the leads perpendicularly to the flat metal reed switch elements, ie, so that when the switch is mounted, the metal leaves inside the capsule are horizontal. This ensures that the switches have a consistent sensitivity to magnetic fields.

With the leads bent, install each switch with the horizontal sections of the leads 9-10mm above the PCB (any higher and the lid won't fit on the box). Start by soldering one lead, then check that the reed switch is perpendicular to the board and at the right height before soldering the other. Make sure that all seven reed switches are the same height above the PCB.

You can then fit the 5mm red LED to the sensor unit control board. **This pokes up through a hole in the reed switch board which is not directly above the LED's pads (see photos).**

Bend the LED's leads so that, with the lens pushed fully up through the hole in the upper board, its leads go through the correct holes in the lower board. Make sure they don't run too close or they could short. The longer (anode) lead must go through the hole towards the bottom of the board.

Pin headers

Now you can join the lower and upper boards of both units. The first job is to screw them together using two 15mm tapped spacers. Insert a 20mm M3 machine screw through the two top mounting holes of each upper board and thread a 15mm tapped spacer on the end. Hold the spacer with flat-nose pliers and turn the screw until the spacer is tight up against the underside of the board.

When finished, the screws will project a few millimetres from the ends of the spacers. Push these through the corresponding holes on the lower board and tighten an M3 nut firmly onto each screw to hold the two boards together. When fully tightened, the two boards are held parallel; see the adjacent photo.

Now push a straightened length of 0.7mm diameter tinned copper wire through one of the 12 holes at the bottom until it won't go any further. For the LED board, solder the wire to the pad on top and trim off the excess. For the reed switch board, cut the wire off flush with the upper PCB and solder it to the pad on the underside (if your reed switch board is double-sided with plated through holes, you can solder it to the pad on the top).

Repeat this for the other 11 holes on each board, to form 12-way pin headers. That done, remove the nuts holding the boards together and separate them, then loosen the spacers slightly so that the screws rotate easily. **You must also remove the right-most spacer at the top of the reed switch board, leaving just one spacer attached to that board and two to the LED board.**

Testing the control boards

Before completing the assembly it's

a good idea to test the control boards one at a time.

To do so, connect a multimeter set to DC amps across the fuse-holder clips and then attach a power supply. If you have a bench supply, set the output to 6V and the current limit to 100mA. Otherwise you can use a battery or another source of appropriate voltage.

Turn the power on and check the current flow. After a second or so it should drop below 50μA on its way to 15μA (depending on your meter, it may read 0.0mA). If you get anything above 1mA, cut the power and check for faults.

If it's OK, install the fuse and check the 3/3.3V regulator's output pin voltage relative to a convenient ground point. It should be within a few percent of the expected figure. If that checks out, cut the power and install the ICs (two for the display unit, one for the sensor unit), orientated as shown in the overlay diagrams. Also plug the 433MHz transmitter in, as shown in Fig.7.

You should now insert the jumper shunts for JP1 and JP2 (see Table 1, published last month) to indicate the correct battery/supply voltage for each board.

Voltage reference adjustment

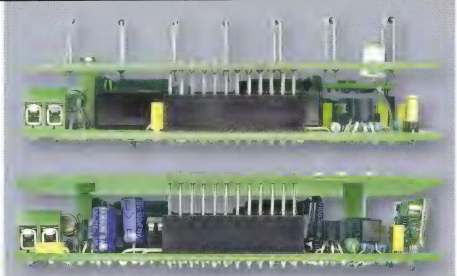
Both boards need an accurate ADC reference voltage (A_{REF}). This can be measured at tests posts TP1 and TP2. However, the ADC reference divider is normally only powered briefly, to save battery power, so some extra steps must be taken.

The sensor unit enables the reference divider for 30 seconds after power is first applied. The display unit does the same but only if its switch contacts (S1) are closed when power is applied. This can be easily achieved by shorting the wires soldered to CON9 using an alligator clip or a blob of solder.

For each unit, switch it on while monitoring the test point voltage (TP1 or TP2). Adjust VR1/VR2 to get a reading very close to 2V (say 1.99-2.01V).

If this takes longer than 30 seconds, the reference divider will switch off and the reading will suddenly change to be close to either 0V or 3V. In this case, switch the power off and wait a few seconds before turning it on again and finishing the adjustment procedure.

When both voltages have been set correctly, remove power and clear the short between the leads soldered to CON9.



Another view showing how the board assemblies are stacked together and connected via the pin headers. Note how the leads of the LED on the sensor control board (top) are bent so that the body of the LED goes through a hole in the sensor board.

Preparing the boxes

The sensor unit requires one small hole to be drilled in its case, for the antenna. Its position is shown in Fig.9. If you are using an external power supply or want to trickle charge the battery you will also need to make a hole for the power connector (either the PCB-mount DC socket or a chassis connector). The cut-out locations for these are also shown in Fig.9.

The situation for the display unit is the same except but it also needs a hole for the momentary pushbutton and it has no provision for a PCB-mount DC socket.

There isn't much room inside the display unit for the rear of the push-button switch. If it's located as shown in the drilling template, the rear terminals end up close to the fuseholder but should clear it. So be careful to drill the hole accurately.

One option for a power input/charging connector is a 3.5mm jack socket and the drilling template shows an appropriate location to mount one. While these aren't really sealed against moisture, the stereo switched type has an internal plastic shell which, in combination with some silicone sealant around the hole, should be able to handle a bit of spray.

A small IP65 or IP67-rated chassis connector (eg, Jaycar PS0789) would be much better at keeping water out but it will need to have minimal intrusion into the case in order to fit.

Once the holes are drilled, test that the components fit through properly. Enlarge them slightly with a tapered reamer if necessary (it's best to make the holes just large enough, for a tight fit). You can then install and wire up the lower boards.

Putting them together

Slip the lower boards into the respective cases and secure them with two self-tapping screws, through the two lower mounting holes. For the sensor unit, you can install a third self-tapping screw in the upper-right mounting hole (temporarily unplug the transmitter module).

To fit the pushbutton for the display unit, first remove the fuse. Then remove the nut and washer from the button and hold them on the inside of the mounting hole. Thread the button onto them from the outside, then hold the nut with pliers while rotating the button clockwise. Do it up tight to form a good seal and then solder the wires from CON9 to its two tabs.

We found the easiest way to do this was to rotate the button so that its tabs were arranged vertically and then solder to the top tab, then undo it half a turn and solder to the other tab before doing it back up half a turn again, for a tight fit. If the tabs are close to the metal parts of the fuseholder you can use a small amount of neutral cure silicone sealant to prevent contact. With the button wired up, replace the fuse.

If installing a power input/battery charging socket in either unit, solder short lengths of wire to the tip and

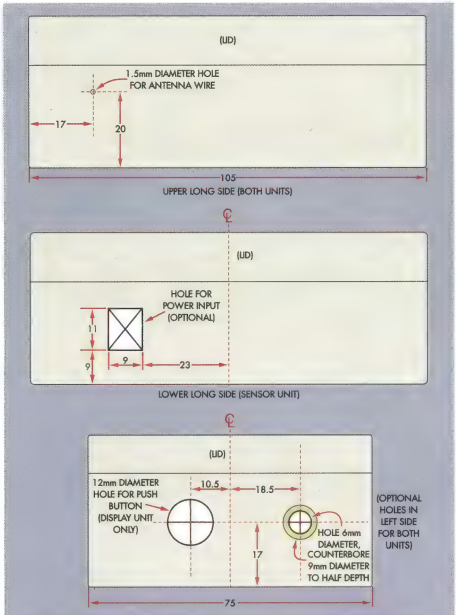


Fig.9: follow these three templates to drill and cut the necessary holes in the two cases. Note that the rectangular cutout for the power connector is optional (sensor unit only), as is the 6mm-diameter hole in the side of the case (both units) – see text.

sleeve tabs and screw the other ends tightly into the terminal block. Then secure the connector to the case. If the connector is not IP65 or IP67-rated, apply neutral cure silicone sealant around the hole where possible to provide a better seal.

The antennas are soldered into place next. First straighten the wires and cut both to a length of 164mm. This is close enough to a quarter-wavelength at 433MHz to give reasonable performance. Scrape the enamel off about 5-10mm at one end of each wire, around the entire circumference, using a sharp hobby knife.

Feed about 15mm of the stripped end in through the hole in each box and use small pliers to bend it to a right angle. Push the wire in further, so that this bent section is against the PCB stake and solder them to each other. Don't heat it for too long or the wire could melt the plastic box (it should only take a few seconds for solder to adhere to the copper wire).

With both antennas soldered in place, bent the sensor unit's antenna so that it sticks straight up with the box lying flat on its back. The display unit's antenna is left as is.

To reduce the chances of eye injury, a small plastic wire joiner (or another small, smooth plastic object such as a sphere with a hole drilled in it) must be glued to the end of each antenna. Fill the wire joiner with hot-melt glue or neutral-cure silicone sealant and push it over the end of the antenna. Do this for both units and once the adhesive has set, trim off any which has leaked out.

It's also a good idea to seal the antenna hole on the inside of the case to prevent moisture ingress.

If you are going to power either unit with a battery, install it now. Then fit the upper boards by carefully lining each pin header up with the socket on the appropriate lower board and pushing the upper board down into place. The upper reed switch board is fitted to the lower board with the small, horizontal transmitter module while the LED board goes on the display unit which has the larger, vertically mounted receiver module on the righthand side.

Push down on and tighten the mounting screws at the top (one for the sensor unit, two for the display unit). The screw threads pass through a hole in the lower board and into the plastic bushes moulded into the bottom of the case. If you don't feel the thread gripping then the screw may be misaligned.

Check that the upper boards are parallel with the bases before screwing the lids in place.

Testing

Apply power to the sensor unit, then wave the magnet close to its reed switches (without touching them). The red LED should light each time a reed switch closes (this may result in a soft click).

If it doesn't work, loosen the screw on the upper board and pull it out using pliers (or slide a thin item under the edge and pry it up). Remove the upper board and check that its pin header was properly connected; if so, the fault is likely on the lower (control) board.

Assuming the sensor unit works, apply power to the display unit and press its pushbutton. One or two LEDs of the battery level meter should light up. If not, remove the upper board and check the pin header alignment and for faults in the control board. It's also possible that one or more LEDs have been installed backwards.

Now with both units powered up,

separate them by one metre or more and move the magnet over the reed switches. The corresponding rudder position LEDs should light up. **If the units are too close together, the wireless link won't work because the input stage of the receiver unit overloads.**

Once you're satisfied that everything is working properly, hold down the display unit's pushbutton for a second or so to turn it off.

Installation

A photo on the following page shows how we installed the sensor unit in our test boat. It is set up so that the magnet hanging from the rudder arm is centred on the reed switches and sweeps from the first to the last as the rudder is moved over its full angular range.

The dimensions of the horizontal arm used in our installation are shown in Fig.11. We initially attached the sensor unit, arm and magnet using foam-cored double-sided tape, to check that the positioning was all correct before making a more permanent installation. We suggest that you do the same. In fact this tape can give a surprisingly strong bond and may be suitable for the final installation. If not, a strong epoxy such as JB Weld can be used to hold the arm to the rudder shaft once the alignment is correct.

Since different boats will vary in terms of their rudder angle, bearing size and so on, you will need to measure yours and make adjustments to the dimensions. If your rudder arm has a larger sweep angle (this one has a full sweep of about around 60°), mount the sensor unit closer to the shaft and shorten the arm. If it has a smaller sweep angle, mount it further away and lengthen the arm. The idea is to ensure that the magnet is over one of the end-switches at full lock.

The sensor unit can be mounted at any position around the rudder shaft but it should be orientated so that a line drawn through the central reed switch would pass through the centre of the rudder shaft.

The arm's vertical offset should be selected so that the magnet is just above the top of the sensor unit's lid. If there's too much of a gap between the magnet and the lid, the reed switches may not operate reliably due to a low magnetic field strength.

The magnet is a type designed specifically for triggering reed switches and we found that this works much better than other magnets, even the strong rare-earth types.

You may find it necessary initially to insert a shim between the arm and magnet to adjust its height and get the unit's response just right. Or depending on the material your crank arm is made from, you may be able to bend it to make adjustments.

We used a curtain bracket for our cranked arm which happened to have dimensions that were pretty close to what we needed. You may be able to find a standard bracket to suit your needs but otherwise, cut a piece of aluminium to size with a hacksaw, file its edges clean and bend it in a vice.

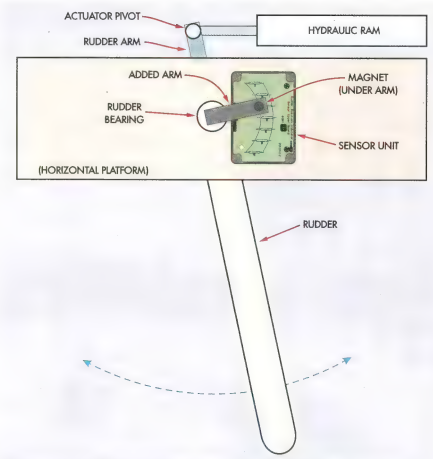


Fig.10: repeated from last month's article, this diagram shows how the sensor unit is arranged. It's mounted on a platform and is activated by a magnet on the underside of an arm that's attached to the rudder shaft.

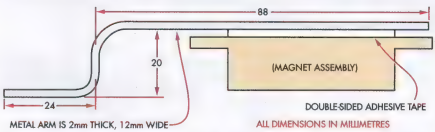


Fig.11: the arm that's used to attach the magnet to the rudder shaft can be fabricated as shown here. Note that the dimensions may need to be altered to suit your particular installation. We secured the magnet assembly using double-sided adhesive tape but a strong epoxy adhesive could also be used.

Range

As stated last month, the reliable operating range for these units is at least 20m. We have confirmed that this figure is realistic on a boat. With our installation, the receiver not only operates anywhere on the boat but it also

The sensor unit is shown here mounted in the lazarette (a compartment under the rear deck of the boat), with the Ultrasonic Anti-Fouling Unit (SILICON CHIP, September & November 2010) immediately to its left. Note how the arm (which carries the magnet) is attached to the rudder shaft. Make sure that the control arm is clear of any obstacles over its full range of travel.

This view shows the completed display unit mounted in the wheelhouse of a large power boat. The indicator LEDs are very bright, even in daylight

works on boats berthed alongside. This is using the whip antennas described here, even with the sensor unit inside an enclosed lazarette compartment.

If you need more range, you can run a coaxial cable to an antenna installed outside the compartment. The simplest method is to install a chassis-mount RCA connector in place of the antenna wire, with the inner pin soldered in place of the PCB stake and its metal tab wired to the adjacent ground pad (not normally used). You can then run a coaxial cable to the external 433MHz antenna.

Using it

After you switch the display unit on, it will show the rudder position once it is changed by moving the wheel (ie, when a reed switch closes). To change the LED brightness, tap the pushbutton. It will cycle through the three possible settings. When you are finished, switch the display unit off by holding down the pushbutton for a second or so. If you forget, it will switch itself off after about 15 minutes of inactivity (ie, if no valid packets received).

While the display unit is portable so that it can be carried between helm positions, it is probably a good idea to install some kind of bracket which can hold it in place while you are steering.

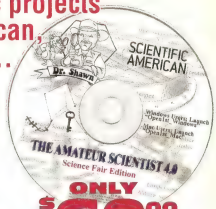
Power loss

If the transmitter unit loses power, eg, when the battery is changed, it will create a new unique identifier. Unless the display unit is also reset, it will ignore transmissions with the new identifier as they do not match that stored in its memory. In this case, you must remove power from the display unit (eg, by taking the battery out and putting it back in) and then it should work normally again. SC

FANTASTIC GIFT IDEA FOR STUDENTS OF ALL AGES!

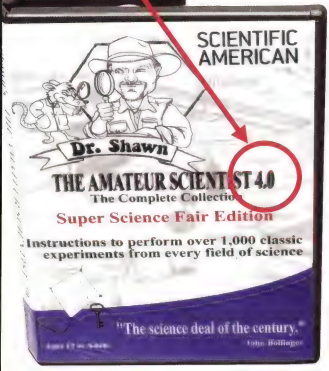
THE AMATEUR SCIENTIST

An incredible CD with over 1000 classic projects from the pages of Scientific American, covering every field of science...



THE LATEST VERSION 4 - WITH EVEN MORE FEATURES!

Arguably THE most IMPORTANT collection of scientific projects ever put together! This is version 4, Super Science Fair Edition from the pages of Scientific American. As well as specific project material, the CDs contain hints and tips by experienced amateur scientists, details on building science apparatus, a large database of chemicals and so much more.



ONLY $62.00

PLUS $10 Pack and Post within Australia

NZ P&P: $AU12.00, Elsewhere: $AU18.00

"A must for every science student, science teacher, science lab . . . or simply for those with an enquiring mind . . ."

Just a tiny selection of the incredible range of projects:

- Build a seismograph to study earthquakes
- Make soap bubbles that last for months
- Monitor the health of local streams
- Preserve biological specimens
- Build a carbon dioxide laser
- Grow bacteria cultures safely at home
- Build a ripple tank to study wave phenomena
- Discover how plants grow in low gravity
- Do strange experiments with sound
- Use a hot wire to study the crystal structure of steel
- Extract and purify DNA in your kitchen
- Create a laser hologram
- Study variable stars like a pro
- Investigate vortexes in water
- Cultivate slime moulds
- Study the flight efficiency of soaring birds
- How to make an Electret
- Construct fluid lenses
- Raise butterflies as experimental animals
- Study the physics of spinning tops
- Build an apparatus for studying chaotic systems
- Detect metals in air, liquids, or solids
- Photograph an ant's brain and nervous system
- Use magnets to make fluids into solids
- Measure the metabolism of an insect . . .
- and many, many more (a thousand more, in fact!)

See the V2 review in SILICON CHIP, October 2004. . . or read on line at siliconchip.com.au

This is the ALL-NEW Version 4 . . . it's even BETTER!

HERE'S HOW TO ORDER YOUR COPY:

BY PHONE:* (02) 9939 3295 9-5 Mon-Fri

BY FAX:# (02) 9939 2648 24 Hours 7 Days

BY EMAIL:# silicon@siliconchip.com.au 24 Hours 7 Days

BY PAYPAL:# PayPal silicon@siliconchip.com.au 24 Hours 7 Days

BY MAIL:# PO Box 139, Collaroy NSW 2097

BY INTERNET:^ siliconchip.com.au 24 Hours 7 Days

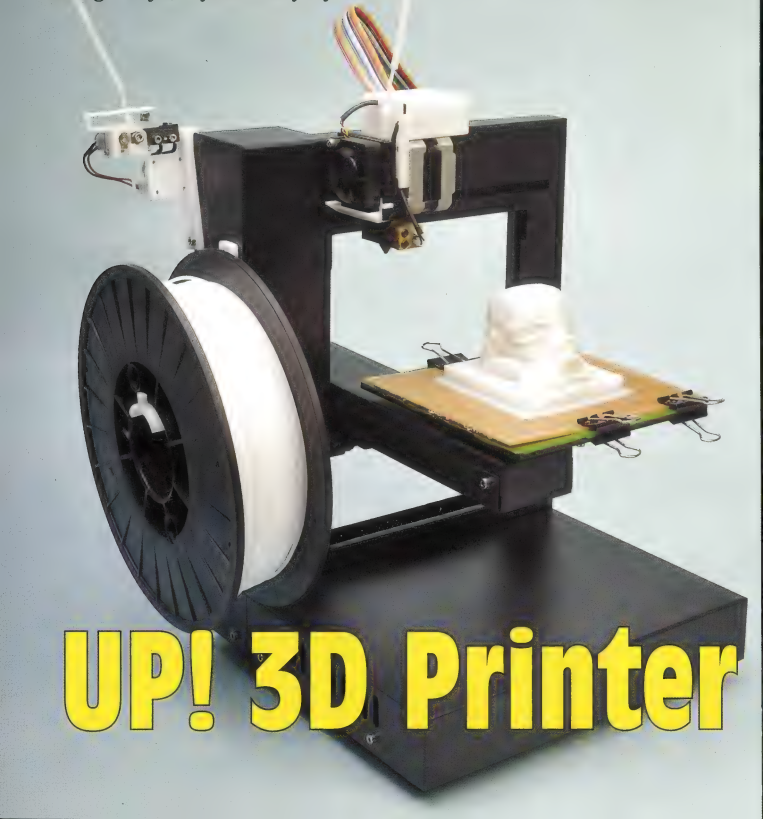
* Please have your credit card handy! # Don't forget to include your name, address, phone no and credit card details. ^ You will be prompted for required information

There's also a handy order form inside this issue.

Exclusive in Australia to: SILICON CHIP siliconchip.com.au

Review by Nicholas Vinen

We've looked at 3D printers in the past but this one is different – you can buy it right now and have it up and running an hour or two after it arrives. You can design objects with 3D CAD software and then watch as they're turned into "the real thing" before your very eyes!



UP! 3D Printer

3D printers have come a long way in the last few years. They are no longer just curiosities. Nor are they so expensive that they're way out of reach. Nor are they the monsters of yesterday.

Recently we were given the opportunity to evaluate a desktop-sized 3D printer from Intellecta, the Australian reseller.

It's the UP! 3D Desktop Printer and it measures just 240(w – plus 55mm for the media roll) x 195(d) x 340(h) mm, with a weight of 5.2kg. That makes it small and light enough to fit just about anywhere.

First impressions count!

The first impression we got upon removing the printer from its packaging is that it is a serious piece of gear. The main part of it is made from powder-coated steel and feels hefty and solid. The stepper motors and gearing are clearly designed for precision; there's no backlash in it at all.

The maximum object size that can be created, 140 x 140 x 135mm, is set by the size of the printing platform and the range of the axes.

However an object that large (or anything close to it) would take many hours to print and as we shall see later, must be carefully designed if it is to be printed without distorting.

On the other hand, smaller objects such as knobs, gears and so on print relatively quickly and there's no real trick to it.

Once the printer has been set up, you just feed the 3D models into the software, press the print button and away it goes. You can print multiple smaller objects in a single print run if desired.

The printer's resolution is excellent, with settings of 0.2mm (fine), 0.3mm (normal) and 0.4mm (fast). This allows for smooth curves and makes relatively fine detail possible.

Objects printed at the higher resolution settings naturally take longer to produce. Roughly speaking, printing a small object takes an hour or so while several small or one medium-sized object will take 2-3 hours. Larger objects will take proportionally longer.

One very good feature is that the entire print job is stored within the printer's memory before printing begins, allowing you to unplug and shut down the host computer while the job continues. This is handy for those larger jobs.

ABS plastic

The objects produced are surprisingly strong and rigid for their size and weight. Acrylonitrile Butadiene Styrene (ABS) plastic is used as the print medium and when this hardens, it is quite tough.

Flexible sections can be made by carefully controlling the thickness and fill density but sections with higher volume feel solid (even if they are filled with a dense mesh, to reduce weight and save on material)

The white plastic is semi-translucent so thin sections are translucent, to a degree. This presents some intriguing possibilities, for example where LEDs could be installed inside, to use as indicators or to create a piece of art. The standard plastic reel is white although differently coloured filaments should be available soon.

Just to emphasise that this printer has practical uses, some of its own parts are printed on another (identical) printer! (You can print a set of spare parts in case one of them breaks).

One of these parts has an actuator arm which bends to trigger a micro-switch, demonstrating the (ahem) flexibility of the printer.

While the printer does most of the work to produce 3D objects, there is some manual work to complete them. Just how much work is involved depends on the shape of the object and specifically how many holes and overhanging sections it has.

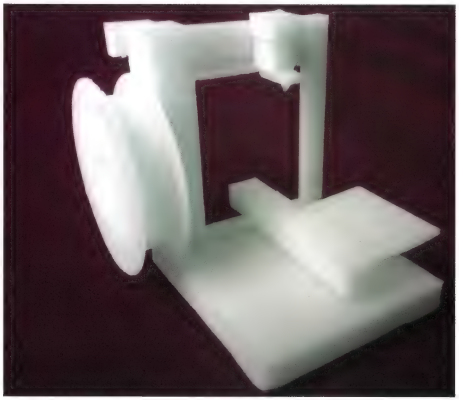
This is because the printer can't deposit plastic in mid-air; the liquid plastic would distort with nothing to support it. So where there is a hole or overhang, it is automatically filled with a sparse plastic lattice. This is dense enough to support the plastic above but much less dense than the object proper and so can be broken or cut away relatively easily.

Sometimes adjacent areas require some sanding or filing to clean them up once these sections have been removed.

Similarly, the entire object is built on a plastic platform (which ensures a level base for the object, regardless of the smoothness of the actual platform) which must be separated from it when it is finished. This is usually pretty easy because the join between them is not very solid and it is perfectly flat, so once you get a utility knife blade between the two it's a simple matter to slice them apart.

Software

The STL file format used is a standard 3D printing file format that can be



Recognise it? It's the 3D printer at right but in this case it's a printed version, in ABS plastic, done by the 3D printer at right!

produced by many 3D CAD (computer aided design) packages.

For the printer to do its job, the 3D model(s) must be converted to a series of thin horizontal slices (with a thickness defined by the print resolution). These slices are shaped by the motion of the x and y-axes in combination with a motor in the print head controlling the rate at which the plastic filament is extruded. Once the slice is complete, the printing platform moves one step lower and the printing of the next layer begins.

The steps required to convert a 3D object into slices and to define the nozzle movements and extruder control are complex, especially when the object has holes or overhangs, as the printer can't simply deposit plastic into thin air. Even for simple solid bodies, the printer moves in intricate patterns, defining the outer boundaries of each slice before filling the internal diagonally. Each layer is built up with a different orientation than the layer below, for maximum strength.

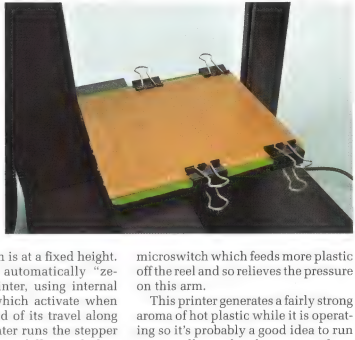
Luckily this is all hidden from you and so you don't have to concern yourself with the details since the software works this all out (although watching the printer work is quite fascinating).

The PC software which accompanies this printer is excellent. It is fast and easy to use. Once the printer is calibrated, all you really need to do is import the STL file(s), let it lay them out on the print platform and then tell it to start. Once the job has been processed and sent to the printer, it warms up the printing platform and also the nozzle to its operating temperature (260°) before proceeding to print.

There are some settings which control the process of converting the objects to slices, in case you need to tweak it for your particular application. For example, you can set the maximum angle of overhang before supporting "scaffolding" is built below it. We generally left the printer at its default settings as these seemed to work quite well.

Operating details

All three axes are controlled with stepper motors. For the x-axis, the nozzle moves left-to-right along a channel at the top of the printer. For the y-axis, the printing platform is moved in and out (ie, front to back). For the z-axis the platform itself is raised and lowered, moving it closer to and further from the nozzle, which is at a fixed height.



The 3D print can be secured to the base by paint supplied with the unit or can be printed onto another base secured to the machine's baseplate. We found the second option much easier and resulted in less problems with image distortion.

The axes are automatically "zeroed" by the printer, using internal microswitches which activate when it reaches the end of its travel along an axis. The printer runs the stepper motors through their full range before printing, so that it can zero each axis. They are controlled so accurately that it can then run for hours without having to re-zero them; it uses relative positioning for the entire print job.

The extrusion head contains a heater, motor, fan and control electronics and is connected to the printer with a ribbon cable. The heater maintains the nozzle at 260°C during operation, melting the ABS plastic filament that it pulls in using an internal motor. The fan runs constantly, keeping the motor and control electronics cool despite the adjacent hot nozzle.

By adjusting the motor speed, the printer can control the rate at which plastic is extruded. This is important, not only because it needs to feed it at a different rate depending on the printing resolution but also since some objects require the nozzle to be lifted and re-positioned periodically and the extrusion is temporarily halted as it does so.

The 1.75mm diameter plastic filament that the extruder consumes comes off a reel on the side of the printer. There is second small motor mounted just above the reel which feeds the filament to the print head.

The way it does this is quite ingenious. The plastic travels from the reel, up through a hole in a flexible plastic arm and then through a clear tube to the print head. As the head pulls the filament in, this causes the clear outer tube to press down on the lever arm at the other end of the tube, triggering a microswitch which feeds more plastic off the reel and so relieves the pressure on this arm.

This printer generates a fairly strong aroma of hot plastic while it is operating so it's probably a good idea to run it in a well-ventilated area, away from where people are working. In terms of noise, it's clearly audible when printing but not too distracting. As well as motor noise, the fan in the print head is quite audible.

Printing platform

The printing platform is quite critical to the operation of this printer and it is something of a paradox. The deposited plastic must stick to it in order to avoid deformation in the object being printed but it can't stick too well or it would be too hard to remove when the printer is finished (and doing so might damage the platform and/or the object).

To solve this, the printer comes with a jar of green latex paint. The ABS plastic sticks to the paint well but the paint layer is quite thin and flexible so the object can still be removed. Some of the paint usually peels off along with it, so it must be frequently re-applied.

A much better solution, according to the distributors, is to clip a section of perforated prototyping board (perf board) to the printing platform with small bulldog clips. It's then quite easy to remove the printed objects and it doesn't need as much maintenance; we much preferred this method. (Obviously you can also easily unclip the perf board if you need to remove it; a less messy procedure than repainting the platform).

You can also use a specific type of masking tape (3M brand). This is mentioned in the manual but we didn't try

Getting down to the nuts and bolts . . . these actually work, the internal and external threads mesh perfectly and could even be used in a non-critical application. The "lacework" underneath is the base on which the parts are printed; this is easily cut away when they are separated from the base plate.

it since the perf board solution worked quite well.

The platform can be removed from the printer by removing two screws. This is necessary after printing onto latex paint, since it can take quite a bit of force to remove objects printed on the paint and doing this could otherwise upset the printer.

Platform heating

Another issue with the platform is that it must be heated. If it weren't, the deposited plastic would cool too rapidly and the resulting object would be badly distorted and poorly formed.

This is most critical with larger objects since they take longer to print and their corners are further from the platform heater, in the middle of the platform.

We found this to be the single biggest challenge when printing objects with large footprints. If the corners lift off the platform due to uneven contraction of the cooling plastic, the object being printed can distort.

The solution is to design the object with "feet" or risers on the bottom, to lift it up so that even if the plastic in the corners distorts, the distortion only affects the "scaffolding" of plastic below the object and doesn't distort the object itself. This helps whether the feet are part of the final object or are designed to be removed later.

The bottom line is that larger objects must be designed with the limitations of the plastic material in mind if they are to be printed flawlessly.

Set-up and calibration

This 3D printer doesn't need much in the way of calibration; it is calibrated before being sent out and it tends to retain its configuration well during transport.

If you want its output to be exact, there are some additional calibration steps in the manual.

Some assembly is required when the printer is delivered. It comes in five main pieces: the X-Y-Z rig, the printing platform, the print head, the plastic feed mechanism and the reel and holder assembly.

Putting these pieces together is fairly easy and takes about fifteen minutes. The parts are held together with hex head screws (Allen keys provided).

The critical part is getting the printing platform level and calibrating the nozzle height. To do this properly it's necessary to remove the part of the X-Y-Z rig which holds the platform and change how it is held in place. This procedure is detailed in the manual. Once it's complete, the platform can be attached and it can then be levelled with the aid of a computer.

The first thing to do is use the computer to command the platform to move towards the nozzle in smaller and smaller increments until there is just 0.2mm spacing between them. This is how printing starts and so the printer needs to be able to move the platform to the correct height each time.

Once the platform height has been set correctly, the nozzle is then lifted up slightly and moved into each corner of the platform in turn. By observing how the clearance changes, you can see whether the platform is level and if not, adjust the screws holding it. As it is moved closer to level, the clearance can be reduced. Eventually the nozzle will "hover" just above the printing platform as it moves around and then you know it is perfectly level and so objects can be printed accurately.

The printer is then ready for use. As for maintenance, it is occasionally necessary to clean any plastic off the print nozzle which may have stuck to it but it doesn't appear necessary to do any periodic re-calibration (although this may be useful in the long term).

Power supply & accessories

The version of the printer we received for review had three separate power supplies but in the latest version (being sold now) this has been reduced to two.

The large "brick" type supply provides 20V at 11A, for driving the motors and heaters. A separate 5V supply drives the motor which feeds the filament to the print head. The printer we reviewed had a second 5V supply for the printer's electronics but this has now been combined with the motor/heater power supply. A USB cable is supplied for connection to the host computer.

A large range of accessories is provided, including practically everything you need to use the printer.

In addition to the printer and the items mentioned above, you get:

- Allen keys and spare machine screws (for assembling and calibrating the printer and for removing/reattaching the platform).
- One 700g reel of ABS plastic.
- Knife and side-cutters (for removing support components of printed objects).
- Tweezers, gloves, spatula, paint.
- Instruction manual.

Consumables

The ABS plastic the printer uses comes on a 700g reel. At the time of printing, replacement reels cost $70 plus GST.

A 700g reel lasts a long time; you can print scores if not hundreds of objects with a single reel (depending on their size and density). We didn't even use

a quarter of a reel during our testing, which was fairly extensive.

As mentioned earlier, reels of coloured plastic are coming soon although each object will have to be printed in a solid colour.

With the latest version of the software, it is now also possible to print using a biodegradable plastic made from corn. If this plastic is being used, the nozzle temperature is reduced since it has a lower melting point.

Uses

One obvious electronic-themed use for this printer is to produce bespoke knobs, mounting hardware, extension shafts, bezels and so on. It could be useful for producing items for rapid prototyping and also for those who restore older equipment (eg, vintage radios) where replacement parts may not be available.

With some careful design it may even be possible to make small prototype enclosures and other components, for prototype evaluation. It's good to be able to check that everything is going to fit before ordering a large production run.

It could also be used to produce gears, gearboxes, arms, levers and so on for robots or robotic vehicles. The ABS plastic is both light and tough so gears made from it should be able to transmit a fair bit of power (although there will obviously be limits).

Another possible use is to make carriages and miniatures for model railroads. Indeed any model-making exercise would benefit from the ability to make custom-shape parts and perhaps even entire miniature models.

And yet another which springs to mind is in marketing and presentations: imagine, for example, the impact of an architectural firm presenting their building design to clients – and then handing each client an accurate, detailed, scale model of that design!

Or perhaps a product designer doing the same with a new product which the client can actually feel, turn upside down, look into and so on.

The possibilities are endless and the costs of production are minimised.

Having seen the miscommunication with offshore manufacturers (especially where language is concerned!), a 1:1 model could be sent with the order, saying "it should look like this!". They'd have to make sure the finished product wasn't produced entirely in ABS white, though! (Don't laugh... we've seen worse!)

Conclusion

While this is an intriguing product and it clearly has many uses, 3D printing isn't the sort of thing that you can take on lightly. There is a learning curve to operating it if you are to get consistently good results. Fortunately, Intellecta and 3D Printing Systems have the knowledge and experience to help those new to 3D printing figure it out.

We were impressed by the quality of the engineering in this unit and the thought put into the hardware and software. It is quite mesmerising to see 3D objects that you just designed appear out of what seems to be thin air.

Many of the objects we printed during our evaluation period were downloaded from a free website called Thingieverse (www.thingieverse.com) and this is a good place to get example models and see what is possible with a 3D printer.

Price & availability

The UP! 3D printer sells in Australia for $3532 plus GST and comes with a 12 month warranty. For more information, contact Intellecta at support@intellecta.net or call (08) 8351 8288 (South Australia). Visit their website at www.intellecta.net. In New Zealand contact 3D Printing Systems on (09) 281 4205 (Auckland) or 3dprinting.co.nz.

You can also visit http://3dprinting-systems.com where you can see videos of the printer in action, see sample printed objects and even request a sample (mention SILICON CHIP).

Printing 3D chocolate . . . would that be to your taste?

Photo: EPSRC

As this review was being completed, a news release appeared which gives 3D printing a whole new flavour – literally!

It has absolutely nothing to do with the machine under test but we thought it interesting enough to add a bite.

While still very much in prototype stage, researchers at the University of Exeter (UK) have produced a 3D Printer which uses chocolate as its medium, rather than ink (or in the case of the printer reviewed, plastic).

Specialist retailers are reported to be very excited about the 3D Chocolate Printer and have already started making enquiries about getting their hands on one. "Imagine a customer coming into your shop, selecting a design on a computer – or bringing in their own – and walking out with that design in chocolate," said one.

Operation is quite similar to the printer reviewed, in that the 3D image is built up layer-by-layer. The tricky part is to get the temperature right to print the layer of chocolate and then make it harden enough for the next layer to first of all attach but just as importantly, to not distort.

Screenshot by Christopher MacManus/CNET

It's not the first time edible printer media have been tried – in 2010 researchers at the University of Cornell (USA) used liquefied foods as the ink in a 3D printer.

PRODUCT SHOWCASE

Real-world electronics education with Circuit Wizard

Circuit Wizard software is a cost-effective solution for electronics education because it combines important processes of circuit design, PCB design, simulation and CAD.

Tools are provided to support learning requirements from early ages right up to senior high school, VET and pre-apprentice, TAFE and university. Analog, digital and microcontroller components can be used in the design.

Students can design and simulate a circuit with real world components, prototype with breadboards, design a real schematic, export to a PCB and program the unique GENIE chips in both flowchart and BASIC programming language. The circuit can then be engraved on a Roland milling machine and placed in a housing that the students may have designed in a CAD package.

Main features include:

- Education, hobby and professional versions
- Circuit design with customisable component library (500 components Standard, 1500 components Professional and Education)
- GENIE microcontroller support (Education version only)
- ANSI and DIN symbols
- Schematic capture
- Virtual instruments (4 Standard, 7 Professional)
- Automatic wiring
- Nets and virtual connections
- Interactive circuit diagram simulation
- On-screen animation
- True analog/digital simulation
- Simulation of component destruction
- Component fault simulation
- Interactive component and pin hints
- Create subsystem blocks
- Multiple document support
- Gerber export

Contact:
Intellecta Technologies
51 George St, Thebarton, SA 5031
Tel: (08) 8351 8288 **Faxl:** (08) 8351 8388
Website: www.intellecta.net

New PIC MCUs and dsPIC DSCs

Microchip has announced a new series of 16-bit PIC microcontrollers and dsPIC Digital Signal Controllers that bring advanced control to cost-sensitive general-purpose and motor-control designs. The new devices enable low-cost, sensorless motor-control designs with support for a wide range of motor-control algorithms, and include an on-chip Charge Time Measurement Unit (CTMU), and 10-bit Analog-to-Digital Converter (ADC), to enable intelligent sensor applications and mTouch capacitive touch sensing.

More information: www.microchip.com

Ever felt like a GOOSE?

CatchAttach for Microsoft Outlook

Hands up if you have ever sent an email with an attachment in Microsoft Outlook – and forgotten to attach the attachment!

Look at all those hands . . . don't you feel like a goose! Now it need never happen again with "CatchAttach". It is designed to do one thing well – and that is to warn you if you forget.

Admittedly, other email applications will do this for you – but not Outlook. This works with Outlook 2007 and 2010 and is a full Outlook plug-in developed using Microsoft's own VSTO technology.

CatchAttach allows you to specify the keywords you use when you attach a file to an email. If it finds any of these keywords when you click the "send" button and there are no attachments you will receive a warning.

It's available as a "free trial" download which nags you until you buy a licence – at just £1.95

Try it for yourself at www.catchattach.com

CR123A Lithium-Ion battery & charger

CR123A batteries are commonly used in LED torches and many cameras – but the replacements are expensive. Now Jaycar Electronics have a rechargeable option with this lithium-ion CR123A battery and matching charger, complete with plugpack supply and cigarette lighter cable.

Normally, Li-Ion batteries have a nominal voltage of 3.7V, which being higher than a normal CR123 battery can damage the sensitive circuitry of LED torches and cameras – but this battery is different! The battery features smart circuitry inside that drops the voltage to 3.0V under load, making it perfectly safe to use with sensitive electronics that normally use a 3.0V CR123 battery. The intelligent design will fully recharge the included battery in about 3 hours and has a LED charge status indicator.

Contact:
Jaycar Electronics (all stores)
PO Box 107, Rydalmere NSW 2116
Order Tel: 1800 022 888 **Fax:** (02) 8832 3188
Website: www.jaycar.com.au

Vintage Radio

By Maurie Findlay, MIE Aust, VK2PW

Restoring The Hotpoint Bandmaster J35DE console radio; Pt.2

Last month, we discussed the Hotpoint Bandmaster J35DE in general terms. This month, we describe how it was restored to its original performance. The only instrument required was an inexpensive digital multimeter and the same general ideas can be applied to most vintage sets.

MANY OF THE ARTICLES on vintage radios in these columns give some of the details of restoration but rarely would a set which looks potentially good on initial inspection turn out to require so much work to restore it to its original standard of operation. And while some people might simply turn the set on and hope for the best, that is not likely to be successful in many cases.

The starting point with this set was the power cord. It was originally fitted with a twin-lead conductor power flex which is not deemed safe these days, especially when a 60-year old power transformer is being used. It might be OK for the present but that cannot be guaranteed.

Accordingly, a 3-conductor flex was fitted, with the chassis correctly connected to mains earth for safety. The power cord was securely anchored with an IP68 cable gland and the green earth wire terminated to the chassis with crimped lug, screw, nut and lockwasher. This works well although using a cable gland may not be an approved method when it comes to anchoring mains cords.

The next step was a resistance measurement of the primary of the power transformer. Measured via the power plug pins it was about 50Ω and from the plug pins to the chassis it was a large number of megohms. So that was OK but the set has a double-pole rotary power switch operated by one of the front-panel knobs and it seemed very tired. Turning the switch backwards and forwards produced an occasional flicker on the meter but not the original 50Ω reading. So it had to be replaced but obtaining the same switch was impossible.

A used switch potentiometer with a double-pole switch rated at 240VAC 2A was found and fitted as a replacement but its shaft was too short. This was extended using a short section of shaft from another pot. They were joined using a threaded bush from yet another pot, the whole lot being glued together with JB Weld epoxy adhesive.

Terminating wires to the switch was yet another hurdle. The solder tags on

the switch pot are of thin sheet metal and not designed to take the strain of stiff wires with mains insulation. For this reason, the mains wires were extended with flexible hook-up wire which was in turn covered with thick plastic tubing.

Fortunately, the original volume control, which is separate from the power switch, was quite usable.

Then we come to the valves. A natural tendency among these new to radio restoration is to pull out the valves and wipe away the dust and grime but this can be a real trap since it is so easy to clean off the label marking. Then how do you identify them? Four of the valves in this set are of similar size and have no connection to a top cap, so it would be easy to mix them up.

So before pulling any valves out of the chassis, do a quick diagram showing the location of each valve and its type. Then put a sticker on the base of each valve and label it as well.

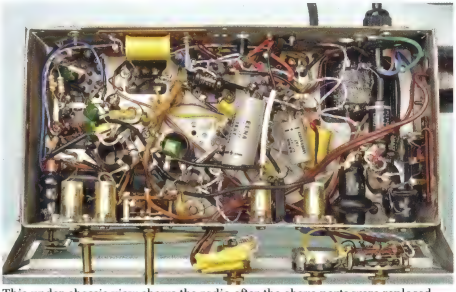
Turning the chassis upside down is another hazard because it needs a rear support to stop it from resting on one of the IF transformers. A length of angle bracket bolted to the back of the chassis provided the necessary support.

Then we could have a detailed look at the components underneath. One manufacturer produced paper capacitors in a black plastic which melted at soldering temperature. Servicemen in the 1950s referred to them as the "black death". It was expected that most of these would be leaky. Surprisingly though, most of the capacitors were OK, both with regard to leakage and capacitance, except for a couple where the ends broke off when the multimeter was connected!

Ultimately though, most of the paper capacitors were replaced with modern metallised polyester types (greencaps etc) as the leads of the originals were so fragile.

The resistors were carbon composition, most about 35mm long and 6mm diameter, and were probably rated at 1W dissipation. Measurements showed that most of the resistors were high in value, some by a factor of two to one but the 325Ω V4 cathode resistor and the 50Ω resistor for the back bias circuit measured both very close to their marked values. They appeared to be wirewound types.

These faulty parts all had to be replaced in the old Hotpoint Bandmaster radio. Most are capacitors but there are also quite a few resistors, a couple of dial lamps and the 6J8G mixer valve.



This under-chassis view shows the radio after the above parts were replaced. It's normally fitted with a perforated steel cover.

Electrolytic capacitors

Electrolytic capacitors in old valve radios usually have a high leakage or if not, they have dried out and have low capacitance. Still, replacements are available from a number of suppliers.

In this particular case, the 4.7μF and 16μF capacitors were salvaged from a junk box and reformed using the electrolytic capacitor tester described in the August and September 2010 issues of SILICON CHIP.

Resistance checks of the power transformer high-tension secondary and heater windings and the two windings in each of the two IF transformers gave the expected readings, being 400Ω for the HT, a low value for the heater winding (since the valve heaters are all in parallel) and about 10Ω for the IFs.

The broadcast-band (BC) aerial coil primary checked out at about 30Ω and the secondary (tuned winding) at about 4Ω. The BC oscillator primary and secondary both measured about the same as the latter. Initially, the shortwave coils were not checked.

Disintegrating wiring

A wire was removed from the 16μF filter capacitor just to check for shorts and its insulation disintegrated just as the wire was moved. Quite a number of other wires in the chassis looked as though they would do the same.

So, the big decision had to be made. Was it worth refurbishing the set to the point where it would be reliable and perform as it did originally? Having

Some of the leads of the speaker transformer had broken off at the base. It was repaired by digging away some of the pitch-like sealant, joining new leads to the exposed wire ends and then resealing the unit.

proceeded this far, there could still be other faults. For example, the tuning slugs in the IF transformers might not work, the rotary switch for BC/SW selection could be intermittent and so it goes on.

In all these cases the answer is as follows: if you are prepared to spend the money on components and hours of fairly skilled work with a soldering iron, a multimeter and long-nose pliers, and you regard the project as a hobby, then it is worthwhile.

Components improved greatly in the 1950s and many of the younger radios that come up for refurbishment would not have as many faults as this Hotpoint. Hopefully, your set would not require as much work.

A general tip: when working on a radio that requires many hours of concentration, don't continue for more than one or two hours without a rest. It is very easy to make a mistake which could be hard to find later.

In this set, many of the components were soldered directly to the chassis during manufacture. A large soldering iron would be required to undo the original connections. The way around this is to cut the wire close to the component after which a new component can be connected to the stub with a normal soldering iron.

Modern components are almost always smaller than vintage parts of the same voltage rating (in the case of capacitors) and power dissipation rating (in the case of resistors). So there is a temptation to terminate the leads in places different to the original. Don't do this. There are often cases where, for example, a different earth termination point could lead to instability. The original designer of the radio would no doubt have spent a lot of time determining the best component connecting points.

The damaged wiring loom presented real problems. There were cases where a wire with damaged insulation was bound up with other wires which appeared OK. In those cases, it was decided to leave the bad wire in place and just cut off the ends. Binding the new wire into the loom risked further disturbing the crumbling insulation so we tried to disturb it as little as possible.

Keeping it original

Many restorers want to keep the radio looking as original as possible. In this case, we left the original electrolytic filter capacitors in place so that the top the chassis looked the same. However, it was just not practical to make the inside of the chassis look original since most of the components have to be replaced in a relatively small space.

No doubt the purists would be aghast but taking the purist approach would be far more time-consuming and all for a result that no-one will see. In particular, as shown on page 96 of last month's issue, the Hotpoint chassis has a screening panel underneath which prevents you seeing inside unless it is removed.

With the passage of 60 years, there are changes to the circuitry of the Hotpoint which could be made to improve performance. However, we have resisted these temptations for the moment and adhered to the original circuit except for some modifications to the output transformer connection (the original circuit allowed the high-tension to remain on the screen of the 6V6GT output valve when the speaker cable was unplugged – see last month's article).

Incidentally, one reader emailed to say that there wasn't any design fault since the circuit shown on page 94 clearly showed a plug with inbuilt HT link. What he hadn't realised was that I had redrawn the circuit (also mentioned in last month's article) to incorporate this modification. Perhaps I should have emphasised that point.

Having replaced all the doubtful parts there comes the critical time to apply mains power. Measure from the high-tension line to ground to make sure that there is high resistance and also from pin 3 to pin 4 of the 6V6GT, to make sure that the primary of the speaker transformer is intact. The latter should measure a few hundred ohms. Of, course the abovementioned speaker plug should be in place.

Place the chassis on the bench so that the valves can be viewed. Switch the power on but have your hand on the mains outlet switch in case anything shows distress. Check the valves. With most types the cathode will glow a dull red.

With the Hotpoint, there were no fireworks and the cathodes were all as expected. The heater element of the 6X6GT protruded out of the cylindrical cathode by about 8mm which isn't normal but the cathode was a normal dull red, so the valve still did its job.

With luck, there will be a gentle hiss from the set with the volume control fully advanced. And with an insulated wire connected to the aerial terminal, you should be able to hear some stations, even if weakly, as the tuning knob is rotated.

But the chances are that you may not be so lucky. In that case, a systematic search through the circuitry will be necessary. This is a good idea anyway because it will pick up any more faulty components, including valves.

Place the chassis so that you can get at the underneath connections and measure the high-tension (HT)

This view shows the complicated dial stringing arrangement, necessary to ensure that the top and bottom horizontal sections both travel in the same direction to carry the long vertical pointer. About 2.4 metres of dial cord is required to complete the job.

voltage across the 16μF filter capacitor. It should be about 250V DC. Then measure the voltage across the 325Ω resistor from the 6V6GT cathode to earth. It should be about 13V which means that the cathode current of the valve is 40mA. If it is much less, it is probable that the valve is low in emission and due for replacement.

To check that the valve is amplifying, switch the meter to the ohms scale, connect the red (normally positive) lead to earth and touch the black lead to the junction of the 47kΩ and 0.47MΩ (470kΩ) resistors. There should be a thump from the speaker. If not, there is most likely a problem in the speaker transformer, the speaker or the connections.

All OK with the output stage? Measure the voltage at the plate (pin 6) of the 6SQ7GT. It should measure about 90V and touching the probe on the pin should result in a click from the speaker. If the voltage is much higher than 90V, the valve is probably low in emission and should be replaced. (Note: this is a case where the cathode current is only about 0.5mA and a usable valve would be failed by an emission tester.) Again, use the ohms setting of the meter from grid (pin 2) to ground to confirm that the stage is amplifying.

Also, the volume control can be checked by using the meter on the ohms scale. Start with the knob turned fully clockwise and note that the sound in the speaker is reduced as the knob is turned anticlockwise.

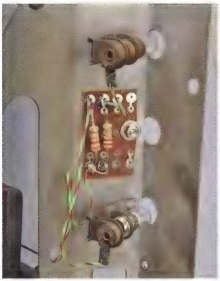
The lefthand knob is marked "PHONO – RADIO" and has positions marked "TREB", "MED" and "BASS" for both the phono and radio functions – six positions altogether. The frequency response of the Hotpoint shown in Fig.1 is for the "TREB" position. The other two positions impose very severe high-frequency audio attenuation.

The plate current of the 6SK7GT can't easily be checked because its cathode is grounded. Measure the resistance of the IF transformer primary with the set switched off. Then, after making sure the screen voltage is about 80V, the plate voltage about 250V and the grid -3V, measure the voltage drop across the IF transformer winding. This voltage divided by the resistance and multiplied by 1000 will give the plate current (in milliamps). With a good valve, it should be about 5mA.

Now with the DMM on the ohms range, briefly touch the probe to the grid (pin 4) of the 6SK7GT. This should result in a slight click in the speaker if the valve is amplifying but not nearly as loud as with the audio stages.

Testing the 6J8G is a special problem in the Hotpoint chassis. The socket for the valve is hidden by the broadcast-band oscillator coil and the accompanying trimmer capacitor. It is just not practical to make contact with the two connections which are needed to determine if the valve is OK, ie, the cathode and the grid of the oscillator section.

As a result, the trimmer was removed and a 1MΩ resistor soldered to the oscillator grid connection on the valve socket (pin 5). The other end of the resistor was left to protrude between the two trimmers so that the meter connection could be made. The voltage reading will be only slightly reduced by the presence of the resistor (the capacitance of the meter leads would affect the oscillator frequency if



A 2.2Ω resistor was wired in series with each dial lamp to improve its reliability. This gives only a slight reduction in brightness.

The shaft of the replacement switch pot was extended using a short section of shaft from another pot. The two were joined using a threaded bush from another pot, the lot held together with JB Weld epoxy adhesive.

a direct connection were made).

In order to get at the 6J8G valve socket cathode connection, the side of the chassis which carries the support for the dial glass and dial lamps had to be removed. A length of hook-up wire was soldered to pin 8 of the socket. This pin is already bypassed to chassis so that the wire can be extended without affecting the performance. Altogether, this was a time-consuming job.

The cathode resistor and the oscillator grid-return resistor were both within 20% of their marked values and because of the difficulty of replacing them, they were left as is. The capacitors were difficult to undo and measure but their effect is easy to determine. If the 70pF capacitor is not about the correct value, the oscillator will not perform correctly across the band.

In addition, the gain of the valve will be low if the bypass capacitor across the 200Ω resistor is low in value. We checked this by connecting a 0.1μF capacitor from the extended wire to earth.

Ohm's law can be applied after measuring the voltage across the cathode resistor. The calculation should indicate about 6mA. It was much less than this with our set and so a new 6J8G was fitted. This fixed the problem of the set not receiving stations at the high-frequency end of the band.

The operating conditions for the 6J8G in the Hotpoint circuit are really not optimum for performance. The grid bias should be lower, giving a higher cathode current and thus increasing the gain and oscillator amplitude.

We did, however, decide to retain the original design where reasonable. Shorting out the 220Ω cathode resistor on the broadcast band is an easy way of proving the point. It improves the sensitivity on the broadcast band by about 6dB. However, to make the grounded cathode legitimate, negative bias has to be restored on shortwave.

The socket for the 6J8G in the Hotpoint chassis is shock-mounted from the chassis. We can only assume that early production versions of the valve tended to be microphonic and that this was done to prevent acoustic feedback from the 12-inch (30cm) speaker which was positioned close to the chassis.

Stringing the dial cord

The dial cord had at some time been re-strung with ordinary string and it just wasn't working as it should. Ordinary string doesn't work as it is too slippery to provide enough friction around the pulley for the tuning knob. And it has to be tensioned properly.

In the case of the Hotpoint, the dial cord arrangement is quite complicated since it supports the long pointer at both the top and bottom of the dial. Cord sections going in the same direction at top and bottom are provided by the special stringing arrangement. In fact, it requires about 2.4m of dial cord.

You have several choices if you cannot obtain dial cord. One approach is to use the cord from slimline venetian blinds and another is to use the thin line used by bricklayers. A third possibility is to use dental floss. Fortunately, the Hotpoint chassis has a diagram for the dial stringing on the back of the dial-plate.

Over-bright dial lamps

Dial lamps in typical vintage radios present a reliability problem if operated at the full heater voltage of 6.3V. They get very hot and they can even lead to cabinet discolouration in those with Bakelite cases.

In the case of the Hotpoint, I decided to wire a 2.2Ω resistor in series with each of the four lamps. This results in a slight reduction in brilliance but also reduces the amount of heat they produce.

IF alignment

The next job was to align the tuned circuits and correct the dial station calibration positions. Bear in mind that the dial was originally designed when the stations were 10kHz apart in frequency; now AM broadcast frequencies have 9kHz spacing. Having said that, most of the major city stations are still close to their original frequencies.

Alignment of the 455kHz intermediate transformers can be undertaken using a local radio station and your digital multimeter (DMM). With care, the job can be done virtually as well as with a signal generator.

The positive lead of the DMM can be connected to chassis and the negative lead to a point on the AGC (automatic gain control) line which is bypassed. In the case of the Hotpoint, this could be across the .047μF capacitor at the bottom of the 1st IF transformer secondary. You may use the chosen point for the whole of the alignment procedure and it could be worthwhile arranging a "hands free" connection to the meter.

You will probably stand the chassis on end so that you can access all the adjustments. Tools such as small screwdrivers should be on hand and plastic alignment tools may be needed if some of the adjustments involve internal slugs.

An aerial wire, say five metres long, should be connected and when you tune accurately to a strong station the meter should indicate a positive value of a few volts. Carefully adjust the tuning capacitor for maximum reading. If there is a choice, use a station at the low-frequency end of the broadcast band.

Then, one by one, adjust the IF transformers for best meter reading. In most cases, the increase in reading will be small and accounted for by the aging of components. If one adjustment does not result in a peak meter reading then the IF transformer is faulty may need to be replaced. This doesn't happen with many sets.

Another possibility is that an adjustment screw or slug has jammed and can't be moved. A decision then has to be made. If, eventually, the set is sensitive enough to receive the stations needed, it could well be a reasonable decision to leave the component in place rather than face a difficult replacement.

The next job is to make the dial pointer agree with the station positions.

Tune to a known station at the high-frequency end of the band and then adjust the trimmer capacitor for the oscillator coil (25pF) so that the pointer indicates the station position correctly. That done, tune to a station at the low-frequency end of the band and adjust the core of the oscillator coil for the dial position.

When the set is tuned back to the high-frequency station, the dial position may have shifted slightly. Correct this again with the trimmer capacitor. It may be necessary to go backwards and forwards two or three times to complete the oscillator line up.

Signal frequency circuits are lined up for maximum sensitivity using the same general idea: adjusting trimmer capacitors towards the high-frequency end and inductors towards the low-frequency end. The tuning capacitor rotates through 180°. Try to make the adjustments near the 20° and 160° points.

Note: the shape of the tuning capacitor plates is the same for both the oscillator and signal-frequency tuned circuits, so tracking can only be perfect at three points on the dial: near the ends and towards the centre. The loss in sensitivity is not too serious, however. Some manufacturers in the late 1950s overcame this problem with tuning capacitors by having differently-shaped plates for the oscillator section.

If your radio has an RF amplifier stage, there will probably be two tuned circuits to adjust but the principle is the same: inductors towards the low-frequency end and trimmer capacitors towards the high-frequency end.

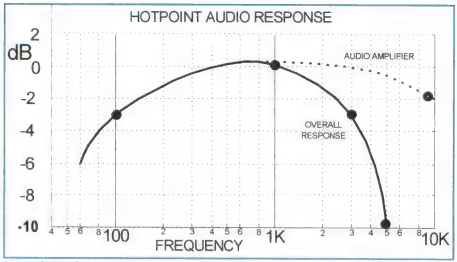


Fig.1: the audio response curve for the Hotpoint J35DE radio. It's 10dB down at 5kHz but most people were happy with a "mellow" tone in the 1950s.

Measured Performance

Audio Output	Max. 3W; undistorted 1W.
Frequency Response	-3dB @ 100Hz & 3kHz, -10dB @ 5kHz.
Receiver Sensitivity	12μV @ 600kHz; 8μV @ 1500kHz; 20μV @ 10MHz

(Signal level at receiver aerial terminal: AM signal 30% modulated @ 1 kHz for 50mW output)

Our Hotpoint presented another design problem: there is no means of adjusting the inductance of the aerial tuned circuits on either the broadcast or shortwave band. All we can do is adjust the trimmer capacitors.

Shortwave alignment without a signal generator does present a problem. The Hotpoint could never be considered as a set for the serious shortwave listener but something should be done so that strong stations can be heard. Simply turn the dial to the middle of the range and with the aerial connected, adjust the trimmer capacitor for maximum noise. This may be sufficient for some.

For those who wish to go further, use can be made of the American station WWV which transmits accurate frequency and time signals from both Hawaii and Colorado. The 10MHz signals can usually be heard at good strength in Australia in the early evening and are identified by a one-second pulse on the audio.

Simply adjust the shortwave oscillator trimmer so that WWV appears at the calibration point on the dial and then adjust the aerial trimmer for maximum volume

Once the dial calibration is correct at 10MHz, it will be easy to find the 25-metre (11.6-12.1MHz) and 31-metre (9.4-9.99MHz) bands. A long outside aerial will be desirable with sets like the Hotpoint because of limited sensitivity.

Shortwave propagation conditions around the world at the present time and probably for the next few years, tend to favour stations between about 4MHz and 12MHz so that it would be reasonable to adjust the aerial trimmer somewhere in the middle of that range.

How accurate is the alignment using the above methods?

We checked the Hotpoint with a laboratory signal generator, output test set and oscilloscope. The centre frequency of the intermediate stage was a few kHz away from the normal 455kHz but this really doesn't matter. We were unable to improve on any other adjustments.

The performance of the receiver is listed in the accompanying panel. The poor audio response is due to the narrow selectivity of the 455kHz IF stage attenuating the sidebands and is typical of AM receivers manufactured in the 1940s and 1950s, when people were happy with a "mellow" tone. The sensitivity, although not outstanding, is adequate for receiving local stations given about 5m of aerial wire extended away from shielding objects. SC

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097 or send an email to silicon@siliconchip.com.au

Large solar panel for lighting system

The Solar Power Lighting System (SILICON CHIP, May & June 2010) is a great project but what if I want to use a solar panel larger than 5W and a larger SLA battery?

The reason I ask is that my site is alpine and winter is horrible for solar energy – shade and clouds. So I believe I would need, say, a 10-20W panel and larger SLA battery to get through "a bad week". (A. C., via email).

● The components in the charger could be used for a 20W panel if inductor L1 is changed to 100µH 5A, the fuse to 6A, and diodes D1 & D2 to MBR20100CT. The 470µF low-ESR capacitors should be paralleled for a total of three in parallel for each. The 0.1Ω 5W resistor should be 0.05Ω, obtained by parallelling two 0.1Ω 5W resistors.

A 100W solar charger was published in February 2011.

Damage to 230VAC 10A speed controller

I recently bought a kit for the 230V AC 10A Full-Wave Mains Motor Controller (SILICON CHIP, May 2009) for my Makita router. Its specs are: universal motor 8.2A, 1850W, speed 22000 RPM. I assembled the PCB with all components, checking all resistors with a multimeter, polarity of all diodes and capacitors etc.

On power up with the router in circuit and advancing the speed control VR1 the router motor jumped forward slightly then advanced smoothly up to full speed. Varying VR1 up and down changed the speed smoothly for a short time.

On turning on the router a second time, the motor failed to start, then after several tries the motor started again and seemed to operate normally. I then adjusted VR2 when the motor started to oscillate slightly which fixed the problem.

After another try the motor suddenly went to full speed; no speed control!

I then followed your fault-finding procedure as per the magazine article, connecting a 12V DC power supply to D3 & ZD1 and checking voltages on the relevant ICs and all seemed normal. On checking Q1, the collector and emitter pins were shorted (consequently no speed control).

I contacted Jaycar who supplied me with another IGBT. On installing this new part the circuit seemed to work normally until suddenly the router went to full speed and no speed control. Checking the IGBT I found the gate, emitter and collector shorted.

Have you experienced this problem before or could you suggest a reason why the IGBT would fail? This circuit has the latest modifications as per your website "Notes & Errata". Is there an equivalent IGBT other than the "Fairchild" brand?

Should I be looking at IC2, Q2/Q3 maybe? The 10Ω resistor and ZD2 seem OK. I would certainly appreciate some help as I have run out of ideas. (J. M., via email).

● Possibly IC2, Q2 and Q3 were also damaged. With such a large router, the motor should be started with the control wound fully anticlockwise and then wound slowly up to the required speed. Starting the router with the control wound up will cause a large starting current that's well over the rated 10A.

The IGBT should be parallel and tightly connected to the side of the box (but must also use the insulating washer) to ensure the device is adequately heatsinked. The IGBT should be rugged enough for the application.

Partial cure for the Ultra-LD Mk2

The quiescent current of the Ultra-LD Mk.2 Amplifier (SILICON CHIP, August & September 2008) I have built seems to drift up and down, gradually increasing to possible thermal runaway.

The only solution I could come up

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine.

Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Competition & Consumer Act 2010 or as subsequently amended and to any governmental regulations which are applicable.

with was to solder a 100Ω thermistor across two of the four bias diodes, mounting it on one the output transistors. The quiescent current is now stable at 50mA. Would this cause distortion in the output stage or is there another way of solving this problem?

I have looked at the Mk.3 version but it would be to difficult and messy to modify the original circuit. Hope you can help. G. H., via email).

● As long as your modification makes the quiescent current reasonably stable then it should not affect the performance.

We agree that attempting to incorporate the Vbe multiplier onto the Ultra-LD Mk.2 would be messy, which is partly why we produced a tiny adaptor PCB which incorporates the new Vbe multiplier and the other modifications such as the 2-pole compensation. The details will be published next month.

Problem with ultrasonic anti-fouling kit

I have finished the assembly of two ultrasonic anti-fouling kits (SILICON CHIP, September & October 2010) but when I set up the first one for a test run, it promptly blew the fuse.

I removed the danger bits and checked the front end again to ensure I have the correct voltage at the test point. I triple-checked that IC2 was in the correct way so I am reluctant to carry on without some guidance from you.

I could assume a dud fuse and try again but I'm uncertain if IC2 will like it. I am doing this for a friend and I'd hate to lose him. (B. B., via email).

● During the first test, when the IC is out of circuit, it is recommended to have the fuse out of circuit. This will prevent the fuse blowing. The IC and fuse can be inserted when the 5V supply is correct.

Ultrasonic anti-fouling cut-off voltage

I'm in the process of installing the Ultrasonic Anti-fouling unit on my boat at the moment and have one question. The unit cuts out if the supply voltage drops to 11.5V. I am planning on using the unit all the time and when the boat is on the marina berth with shore power that is fine.

However, when away or if the power fails I'd prefer the unit to cut out at ei-

Publisher's Letter – Continued From Page 2

their behaviour, as far as "carbon" emissions are concerned.

The whole process is ridiculous, of course. Even people who are concerned about global warming acknowledge that the "carbon" tax will do little to reduce Australia's carbon dioxide emissions and nothing to reduce carbon dioxide concentration in the atmosphere, presently around 390 parts per million and growing.

But those people with a strong belief in global warming must now finally be starting to have just a little doubt in the science which has been previously proclaimed to be "settled". A few weeks ago, researchers from the US National Solar Observatory (NSO) and the Air Force Research Laboratory released a report on sunspot activity and concluded that the Earth might be heading into a prolonged period of cooling, similar to the Maunder Minimum (1645-1715). This was backed up by another report by Mike Lockwood, professor of space environment physics at Reading University,

You can read more at **www.dailymail.co.uk/sciencetech/article-2010757/Shivering-Britain-Little-Ice-Age-way.html**

I wonder if they got the idea from my Publisher's Letter back in the September 2009 issue? Just kidding.

Of course, the global warming enthusiasts immediately had an answer for that, with Joanna Haigh, professor of atmospheric physics at Imperial College, London, saying that global warming could reverse a cooling effect. "Even if the predictions are correct, the effect of global warming will outstrip the Sun's ability to cool even in the coldest scenario . . ."

Problem is, global warming hasn't really been happening since 1998, a fact that has finally been acknowledged in a new study published in the Proceedings of the National Academy of Sciences: "Humans affect the climate in two ways. They warm it by emitting carbon dioxide and other greenhouse gases and they cool it by emitting sulphur in the form of sulphate particles which have the effect of reflecting sunlight," said lead author Robert Kaufmann from Boston University.

"This means that taken together, humans have had relatively little effect overall on global average surface temperatures over the 10 years, which means that natural fluctuations have predominated," he added.

Which means that they are trying to have it both ways, doesn't it? You will see just how they are playing around with the findings and still trying to make out global warming is happening by reading the story at **http://www.bbc.co.uk/news/science-environment-14002264**

But any reasonable person might easily conclude that global warming simply isn't happening. It's actually getting cooler. In fact, the last two winters in the Northern Hemishere have been extremely cold.

So what the hell are we worried about? And why is Australia contemplating the introduction of a "carbon" tax? Mind you, the federal government presently is letting nothing deflect it from its quixotic course which could do great harm to our present relative economic well-being, with rising electricity charges being only a part of it.

The only thing that makes me hope that it might all amount to nothing is this government's record to date with its so-called innovations and "reforms". The great pink batt innovation comes to mind and of course, there is the latest fiasco, whereby many domestic grid-feed solar panel installations are now acknowledged be defective by the state governments in Queensland & New South Wales.

I know that global warming believers will regard all of the above as heresy, and would probably like to have "denier" tattooed on my forehead. Very well. So be it.

However, I do hope that good sense will ultimately prevail in Australia and that we will continue to thrive, for the benefit and well-being of everyone in this wonderful country. Let's not jeopardise what we have and put ourselves in the same category as the USA and Europe.

Leo Simpson

Next month in Silicon Chip: September 2011

CadSoft EAGLE PCB Design Software

Have you been wedded to Protel Easytrax or Autotrax as your favourite CAD PC software? But hey, it's so last century, DOS and all that. Now there is an affordable alternative which runs on Windows, Mac OSX and Linux. A free version is available with limited functions for non-commercial use. We will have a comprehensive review.

High-Quality Headphone Amplifier

Would you like an amplfier with the superb performance of the new Ultra-LD Mk.3 to drive your favourite high-quality stereo headphones? Well, you can, without the power supply, case and all the paraphernalia of a big stereo amplifier. It's powered from an AC plugpack and fits in a compact half-size 1U case.

Ultrasonic Tank Level Meter

This cunning project measures the level of fluid in a tank by bouncing an ultrasonic beam off the surface of the liquid and then computes the answer. Uses a trusty PIC16F88 microcontroller, one dual op amp, one dual comparator and a bunch of transistors.

Ultra-LD Mk.2 Upgrade PCB

Are you annoyed that we produced the superior Mk.3 version of the Ultra-LD amplifier and you're stuck with the Mk.2 version? Don't let your brow become too furrowed. We've produced a teensy adaptor PCB which lets you incorporate the new Vbe multiplier, the two-pole compensation and other mods to let you get the same performance as the Mk.3. Woo-hoo! Three "ultra" projects in the one issue – what bliss!

Note: these features are in the the process of preparation for publication and barring unforeseen circumstances, will be in the issue.

ON-SALE: Wednesday, 31st August 2011

ther a 25% state of discharge which is 12.55V or at 50% SoD which is 12.20V. Can you tell me the voltage between TP0 and TP1 to achieve this please? (P. C. via email).

- You do not change the voltage at TP1. That should be set to 5V, as specified to give correct operation of the microcontroller.

What you need to do is adjust the resistors connecting to pin 5 of IC1 so that, at your selected low voltage cut-out point, the voltage is 3.83V. That is a bit tricky, as you will find if you do the calculations with standard resistor values. We suggest that you increase the 20kΩ resistor to 22kΩ. That will give a low-voltage cut-out point of 12.25V.

TV audio thump problems

I am hoping you might be able to help me with a little problem.

My situation is that I have a new LCD TV and am using the audio line out to operate through some 2.1 amplified PC speakers. When the TV is switched off with the remote, it enters a lower power mode for several minutes, drawing 20W, and then goes into very low power mode, drawing 0.5W. When it enters the very low power mode a large DC thump is delivered to the amplified speakers which is obviously annoying.

Using the digital output from the TV works well, except it is a constant output and cannot be adjusted by the TV remote volume controls, which is what I want to do.

I know it's easy to switch off the speakers but it's often forgotten. I'm wondering if you know of a simple circuit/project designed to sit between the TV's line out sockets and the amplifier, where it would disconnect after a predetermined period of no signal (say, five minutes), then reconnect shortly after a signal returns. Obviously it would need to wait at least a second or two before reconnecting, otherwise the DC thump would still be heard.

I tried using one of the new power boards that have a master socket and that are capable of switching off anything plugged into the slave sockets, but as the TV draws 20W in the lower power mode, it's not low enough to trip the slaves before the very low power mode. (L. B., Currumbin Waters, Qld).

- Our VOX project from last month (July 2011) should be the answer. This switches on a relay whenever it detects a signal and switches off after a period of no signal. The relay can be used to power up and power down the powered speakers.

At present there are no kits available but Silicon Chip can supply the PCB for $25.00 plus $10 for postage and packing.

Ultrasonic cleaner fuse blowing

I recently purchased a Jaycar kit for the Ultrasonic Cleaner described in the August 2010 issue of Silicon Chip. I completed the kit and applied power without the IC installed, as stated in the instructions. However, I immediately noticed that the device was drawing an excessive amount of current and the fuse blew.

I double checked all the components with no faults found. I then removed the transformer and replaced the fuse. This proved to be OK, without the fuse blowing (IC still removed). I confirmed 5V on pins 1 & 8 of the IC; this checked out fine (without the transformer installed).

The Jaycar kit came with a prewound transformer. I checked to see if this was correct. On visual inspection of the transformer, it appeared to be OK, with the windings going to the correct pins on the transformer.

Can you please assist me with any other ideas or help? (P. H., via email).

- Take the fuse out also when the IC is out. This will prevent the excess current. Then adjust the 5V with trimpot VR1. The fuse and IC can then be reinserted after the power is switched off.

The reason that the fuse may blow with IC1 removed is that the gates of the two Mosfets do not have any drive signal and they can "float" and thereby at least partially turn both Mosfets on; thus blowing the fuse. When the fuse is removed as well as IC1, there is no voltage on the Mosfet drains and so no current can flow.

We do have another version of this circuit in development for another project and we have added 10kΩ resistors

between both gates and the 0V line. This will mean that if constructors leave the fuse in when the microcontroller is out of circuit, both Mosfet gates will effectively be grounded and they will not be able to conduct.

You could add these resistors to the underside of your Ultrasonic Cleaner PCB if you wished but once you have set the trimpot for 5V and installed the unit, that modification will probably never be required.

Bigger inverter wanted

I read with considerable interest the article starting on page 78 of the May 2011 issue on the 12V 100W inverter.

As an amateur operator a device like this would be very useful when powering a 100W transceiver from a 12V battery. Many 100W HF transceivers do not like operating with a supply voltage much below 13.8V, mine included. Their RF output slumps very considerably with quite small voltage drops.

What modifications to this design are needed so that it can operate at up to about 22A continuously for up to five minutes with a 13.8V output, with a rest time of five minutes before another period of full output? Also does this inverter generate radio frequency interference? If the interference is noticeable, can the inverter be automatically switched off when the transceiver is on receive and drawing no more than 2A? (R. C., Mooroopna, Vic).

● Your requirement means that the DC-DC converter would have to deliver 303W (ie, 22A at 13.8V). That's a very big ask. Neither the diodes (D1 & D2), the inductor (L1) or the capacitors or the terminals would be suitable and all would have to be upgraded.

In addition, R1 would need to be 0.01Ω 10W and Q1 would need another Mosfet in parallel. The biggest problem is that the PCB tracks are not rated for this current. A modified design would be around twice the size with a new PCB. SC

Notes & Errata

Dual Tracking Power Supply (June & July 2010): the circuit diagram on pages 70-71 of the June 2010 issue shows the wiper of VR2 connected to one end of the track when it should not be. The circuit board and overlays are correct.

In addition, the two wires from the "LED PWR" connector on the main board to the front panel board should be swapped on the wiring diagram on page 84, July 2010.

Finally, the wiring for the Jaycar LED panel meter shown is correct according to the manufacturer's data sheet but we have found that the connections to its pins 7 & 8 (or pins 5 & 6 on the front panel board) must be swapped for it to work correctly. In practice, this simply involves swapping the yellow and red wires to the display connector.

Surf Sound Simulator, Circuit Notebook, July 2011: the circuit on page 87 should show the 680kΩ resistor connected to pin 13 of IC1d rather than pin 14.

SILICON CHIP

siliconchip.com.au

YOUR DETAILS

LOOK! EVEN LOWER PRICES!

High Aussie $ means imported books are now even lower in price!

Order Form/Tax Invoice

Silicon Chip Publications Pty Ltd
ABN 49 003 205 490

PO BOX 139, COLLAROY NSW 2097
email: silicon@siliconchip.com.au
Phone (02) 9939 3295 Fax (02) 9939 2648

This form may be photocopied without infringing copyright.

Your Name_____ (PLEASE PRINT)

Address_____

Postcode_____ **Daytime Phone No. (** **)**_____ **Email address** _____

Method of Payment: ❑ EFT (ring or email for details) ❑ Cheque/Money Order ❑ PayPal ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | Card expiry date: | | | | |

Signature_____

YOUR ORDER SILICON CHIP PRINTED EDITION SUBSCRIBERS# QUALIFY FOR 10% DISCOUNT (except on subscriptions!)
SIMPLY TICK THE ITEMS REQUIRED – DON'T FORGET TO FILL IN DETAILS ABOVE. WE'LL WORK THE TOTAL OUT FOR YOU AND SEND YOU A RECEIPT WITH YOUR ORDER

SILICON CHIP SUBSCRIPTIONS (all prices include P&P)

- ❑ AUSTRALIA 6 MONTHS (INC. GST) $52.00
- ❑ AUSTRALIA 12 MONTHS (INC. GST) $97.50
- ❑ AUSTRALIA 12 MONTHS WITH BINDER (INC. GST) $115.00
- ❑ AUSTRALIA 24 MONTHS (INC. GST) $188.00
- ❑ AUSTRALIA 24 MONTHS WITH 2 BINDERS (INC. GST) $222.00
- ❑ NEW ZEALAND 6 MONTHS (AIR MAIL) $AU55.00
- ❑ NEW ZEALAND 12 MONTHS (AIR MAIL) $AU99.00
- ❑ NEW ZEALAND 24 MONTHS (AIR MAIL) $AU196.00
- ❑ OVERSEAS (EXCEPT NZ) 6 MONTHS (AIR MAIL) $AU80.00
- ❑ OVERSEAS (EXCEPT NZ) 12 MONTHS (AIR MAIL) $AU140.00
- ❑ OVERSEAS (EXCEPT NZ) 24 MONTHS (AIR MAIL) $AU265.00

NEW! CONVENIENT AUTOMATIC SUBSCRIPTION RENEWAL:

❑ Tick here if you'd like us to *automatically* renew your subscription when it elapses (ie., 6 month, 12 month or 24 month). We'll renew until you tell us to stop!

BACK ISSUES/ARTICLE PHOTOCOPIES

❑ **SILICON CHIP BACK ISSUES*; SC/EA/ETI PHOTOCOPIES**
– *includes P&P* – $12.00 within Australia; $15.00 overseas

*where in stock - photocopy of article supplied where issue is out of stock. EA/ETI: no back issues left, only photocopies available. Price is for each back issue or each article photocopy.

Nominate issue and article required: Month:..... Year.....

Article required:.....

Please attach list if more than one back issue or photocopy required. There is a 10% discount for ten or more back issues and/or photocopies (no further discount applies).

SILICON CHIP MAGAZINE BINDERS

❑ **Embossed "SILICON CHIP", securely holds 12 months+ of issues**
Available in Australia only $14.95
(P&P is $10.00 per order; buy five or more in one order for FREE P&P)

P&P RATES:
Subscriptions, back issues and project reprints: P&P included
Binders *(available Australia only)*: $10.00 per order; for 5 or more P&P is free.
Books: Aust. $10 per order; NZ: $AU12 per book; Elsewhere $AU18 per book

SILICON CHIP BOOKSHOP (P&P additional – See below)

❑ **PERFORM. ELECT. FOR CARS PLUS ELECTRONIC PROJECTS FOR CARS (2003)**
***– last few, some may be shop-soiled, –* BOTH BOOKS ...~~$21.95~~ now only $15.00**

- ❑ AC MACHINES **$66.00**
- ❑ AMATEUR SCIENTIST CD *NEWEST Version 4.0* **$62.00**
- ❑ AUDIO POWER AMPLIFIER DESIGN – SELF ....new low price! ....~~$114.00~~ $81.00
- ❑ BUILD YOUR OWN ELECTRIC MOTORCYCLE .. ....~~$47.95~~ $40.00
- ❑ DVD PLAYERS AND DRIVES ....new low price! ....~~$85.00~~ $71.00
- ❑ ELECTRIC MOTORS AND DRIVES ....~~$60.00~~ $51.00
- ❑ NEWNES GUIDE TV & VIDEO TECHNOLOGY ....new low price! ....~~$58.00~~ $49.00
- ❑ OP AMPS FOR EVERYONE ....new low price! ....~~$110.00~~ $100. 00
- ❑ PIC IN PRACTICE **$60.00**
- ❑ PIC MICROCONTROLLERS - KNOW IT ALL ....~~$90.00~~ $83.00
- ❑ PIC MICROCONTROLLER - PERSONAL INTRO COURSE **$60.00**
- ❑ PRACT. GUIDE TO SATELLITE TV (7th edition) **$49.00**
- ❑ PRACTICAL RF HANDBOOK ....new low price! ....~~$73.00~~ $61.00
- ❑ PRACT. VAR. SPEED DRIVES/POWER ELECT. ....new low price! ....~~$80.00~~ $73.00
- ❑ PROG. 32-BIT MICROCONTROLLERS IN C ....new low price! ....~~$94.00~~ $79.00
- ❑ PROGRAMMING AND CUSTOMIZING THE PICAXE **NEW!** **$65.00**
- ❑ RADIO, TV AND HOBBIES ON DVD-ROM **$62.00**
- ❑ RF CIRCUIT DESIGN ....new low price! ....~~$74.00~~ $63.00
- ❑ SELF ON AUDIO (2nd edition) ....new low price! ....~~$82.00~~ $69.00
- ❑ SMALL SIGNAL AUDIO DESIGN ....new low price! ....~~$103.95~~ $88.00
- ❑ SOLAR SUCCESS – GETTING IT RIGHT EVERY TIME **$47.50**
- ❑ SOLAR THAT REALLY WORKS **$42.50**
- ❑ SWITCH. POWER SUPPLIES A-Z (inc CD-ROM) new low price! ....~~$100.00~~ $91.00
- ❑ TV ACROSS AUSTRALIA ....new low price! ....~~$39.95~~ $39.00
- ❑ USING UBUNTU LINUX **$27.00**

#10% discount offer does not apply to online edition subscribers nor to website orders

To Place Your Order:

eMAIL (24/7) *silicon@siliconchip.com.au* with order & credit card details

OR

FAX (24/7) This form (or a photocopy) to (02) 9939 2648 with all details

OR

PAYPAL (24/7) Use PayPal to pay *silicon@siliconchip.com.au*

OR

PHONE • (9-5, Mon-Fri) Call (02) 9939 3295 with your credit card details

OR

MAIL This form to PO Box 139, Collaroy NSW 2097

*ALL ITEMS SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES IN AUSTRALIAN DOLLARS AND INCLUDE GST WHERE APPLICABLE.

MARKET CENTRE

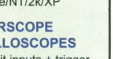
Cash in your surplus gear. Advertise it here in SILICON CHIP

ELNEC IC PROGRAMMERS

High quality
Realistic prices
Free software updates
Large range of adaptors
Windows 95/98/Me/NT/2k/XP

CLEVERSCOPE USB OSCILLOSCOPES

2 x 100MSa/s 10bit inputs + trigger
100MHz bandwidth
8 x digital inputs
4M samples/input
Sig-gen + spectrum analyser
Windows 98/Me/NT/2k/XP



IMAGECRAFT C COMPILERS

ANSI C compilers, Windows IDE
AVR, TMS430, ARM7/ARM9
68HC08, 68HC11, 68HC12

GRANTRONICS PTY LTD

www.grantronics.com.au

SPLat CONTROLS Tough times demand innovative solutions!

In tough economic times you need to watch every dollar. SPLat embedded controllers give OEMs more functionality per dollar than any competing product. Check out our website today and discover how we can help you remain competitive.

Made in Australia, used by OEMs world-wide

splat-sc.com

537 Kits, Modules and Boxes

Innovative & affordable projects for hobby, school & industry

3",5",7",9",10" Super Bright Displays

Shop on-line at:
www.kitstop.com.au
electronics-the fun starts here

THE ULTIMATE PORTABLE AIR BAND, FM/AM/LW & SHORTWAVE RECEIVER!

Perfect for aviation enthusiasts = the amazing Tecsun PL660

Listen in to VHF aircraft frequencies plus NDB signals on long wave, PLUS ICAO and VOLMET broadcasts on HF (SSB) – and you get your favourite AM & FM stations too!

ONLY $175 INC P&P

- HUGE LCD Display
- Direct Frequency Entry
- Inc. rechargeable batteries!

Exclusive to Aveomm. Call now – (02) 9939 4377

For more details visit www.aveomm.com.au

Battery Packs & Chargers

Siomar Battery Engineering
www.batterybook.com
Phone (08) 9302 5444

MEAN WELL Power Supplies On The Net
www.radioandelectronics.com
Ph: 1300 495 211 Fax 08 9402 1287
Email: sales@radioandelectronics.com
PO Box 780, Hillarys, WA 6923

Printed Circuit Board Manufacture
48-Hour service * High quality * Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote...
INSTANT PCBs, PO Box 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

FOR SALE

PCBs MADE, ONE OR MANY. Any format, hobbyists welcome. Sesame Electronics Phone (02) 8005 6732. **sesame@sesame.com.au www.sesame.com.au**

questronix.com.au – audiovisual experts solve home, corporate security and devotional installation & editing woes. QuestAV CYP, Kramer TVone (02) 4343 1970 or **sales@questronix.com.au**

LEDs! Nichia, Cree and other brand name LEDs at excellent prices. LED drivers, including ultra-reliable linear driver options. Many other interesting and hard-to-find electronic items! **www.ledsales.com.au**

SILICON CHIP PCBs: Silicon Chip Publications can supply PCBs for any project described in SILICON CHIP since January 2011. Phone (02) 9939 3295 or email **silicon@siliconchip.com.au** for details.

MAXIMITE BREAKOUT BOARD: 10 channels, 2 relays per board. 2 boards can be cascaded to get all 20 channels. Each channel can be configured as Digital In, Digital Out or Analog In, Screw terminals. More information **www.hamfield.com.au**

KIT ASSEMBLY

KEITH RIPPON KIT ASSEMBLY & REPAIR:

* Australia & New Zealand;
* Small production runs.

Phone Keith 0409 662 794. **keith.rippon@gmail.com**

WANTED

CUSTOMERS WANTED: Truscotts Electronic World – large range of semiconductors and passive components for industry, hobbyist and amateur projects including Drew Diamond. 27 The Mall, South Croydon, Melbourne. Phone (03) 9723 3860. **sales@electronicworld.com.au**

Advertising rates for these pages: Classified ads: $29.50 (incl. GST) for up to 20 words plus 85 cents for each additional word. Display ads: $54.50 (incl. GST) per column centimetre (max. 10cm). Closing date: 5 weeks prior to month of sale. To book, email the text to **silicon@siliconchip.com.au** and include your name, address & credit card details, or fax (02) 9939 2648, or phone (02) 9939 3295.

Do you eat, breathe and sleep TECHNOLOGY?

Opportunities exist for experienced Sales Professionals & Store Management across Australia & NZ

Jaycar Electronics is a rapidly growing, Australian owned, international retailer with more than 60 stores in Australia and New Zealand. Due to our aggressive expansion program we are seeking dedicated sales professionals to join our retail team to assist us in achieving our goals. We pride ourselves on technical expertise from our staff. Do you think that the following statements describe you? Please put a tick in the boxes that do:

- ☐ Knowledge of core electronics, particularly at a component level
- ☐ Retail experience, highly regarded
- ☐ Assemble projects or kits yourself for your car, computer, audio etc
- ☐ Have energy, enthusiasm and a personality that enjoys helping people
- ☐ Opportunities for future advancement and development
- ☐ Why not do something you love and get paid for it?

Please email us your application & CV in PDF format, including location preference. We offer a competitive salary, sales incentive and have a generous staff purchase policy. Applications should be emailed to

jobs@jaycar.com.au

Jaycar Electronics

Jaycar Electronics is an Equal Opportunity Employer & actively promotes staff from within the organisation.

RFMA RF Modules Australia

Low Power Wireless Connectivity Specialists

SENA ZIGBEE
Serial & USB Adapters
2.4GHz. 250kbps
+20dBm EIRP
IEEE 802.15.4
External Antenna
ProBee: ZS10 & ZU10

Applications:
Rural
Utilities
Industrial
Commercial
Government
Meter Reading

SENA ZIGBEE
ZE10 OEM Modules
Full UART
Analog inputs
13 Digital I/O
Antenna options available
ZE10-SK01 Starter Kit

SENA: Bluetooth, ZigBee, Serial Device Servers

RF Modules Australia. P.O. Box 1957 Launceston, TAS., 7250.
Ph: 03-6331-6789. Email: sales@rfmodules.com.au. Web: rfmodules.com.au

CIRCUIT IDEAS WANTED

We pay up to $100 for contributions to Circuit Notebook or you could win a piece of test gear. send your circuit idea to: Silicon Chip Publications, PO Box 139, Collaroy, NSW 2097.

DOWNLOAD OUR CATALOG AT
www.iinet.net.au/~worcom

WORLDWIDE ELECTRONIC COMPONENTS
PO Box 631, Hillarys, WA 6923
Ph: (08) 9307 7305 Fax: (08) 9307 7309
Email: worcom@iinet.net.au

Issues Getting Dog-Eared?

REAL VALUE AT $14.95 PLUS P&P

Are your SILICON CHIP copies getting damaged or dog-eared just lying around in a cupboard or on a shelf? Can you quickly find a particular issue that you need to refer to?

Keep your copies of SILICON CHIP safe, secure and always available with these handy binders

Available Aust. only. Price: $A14.95 plus $10.00 p&p per order (includes GST). Just fill in and mail the handy order form in this issue; or fax (02) 9939 2648; or call (02) 9939 3295 and quote your credit card number.

Advertising Index

Altronics	72-75
Amateur Scientist CD	85
Aust. Exhibitions & Events	101
Avcomm	103
Dick Smith	12-13
Digi-Key Corporation	3
Dyne Industries	6
Emona Instruments	5
Front Panel Express	6
Grantronics	103
Hare & Forbes	OBC
Harbuch Electronics	11
HK Wentworth	4
Instant PCBs	103
Intellecta Pty Ltd	61
Jaycar	IFC,49-56,104
Keith Rippon	103
Kitstop	103
LED Sales	103
LHP.NET.AU	IBC
Microchip Technology	7
Ocean Controls	10
Quest Electronics	103
Radio & Electronics Pty Ltd	103
RF Modules	104
Sesame Electronics	103
Silicon Chip Binders	104
Silicon Chip Bookshop	42-43
Silicon Chip Order Form	102
Silicon Chip PCBs	103
Silicon Chip Subscriptions	31
Siomar Battery Engineering	9,103
Soundlabs Group	8
Splat Controls	103
Switchmode Power Supplies	45
Tenrod Pty Ltd	25
Truscotts Electronic World	103
Wagner Electronics	47
Wiltronics	11
Worldwide Elect. Components	104

LHP.NET.AU

THE SMART CHOICE

Day Night Hi Res SONY Chip CCD Camera

Dome or bracket style

ONLY $88

Silent Sine Wave Generator

240VAC Power, 4.4KVA: **$799**

2kVA also available: **$499**

Battery Charge Controller

Protect your battery from overcharging. PLUS: LCD display shows you the amount of power you are using and producing. Also lets you know battery VDC and Batt capacity Pecentage.

From $89

INFOMON COOLING FRIDGE - FREEZER

This is one tough Fridge Built to Last. Latest technology interface + Design Great for mobile remote use. Micro Computer Temp Control energy saving system so it does not stress out your batteries.

45L was $1499 NOW **$ 769**

60L was $1699 NOW **$799**

80L was $1899 NOW **$899**

FREE BONUS : Insulation Cover, Wall charger and cigarette adaptor.

Solar Panels

BEST PRICES IN AUSTRALIA!

20w $59
50w $150
80w $250
100w . . . $300
120w . . . $350
200w . . . $599

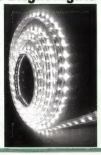
Each solar panel features a 25 year power warranty

SPECIAL OFFER for SILICON CHIP READERS: FREE DELIVERY AUSTRALIA WIDE!

LED 12vdc Bright Lights

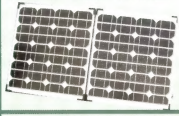
Great for camping tent, caravan etc.5m Roll easily cuts to size. Waterproof + adhesive back fast easy installed.

ONLY $49



Folding Solar Panels

All come in a carry bag, regulator, cable and leads – **READY TO USE!**



60 watt **$199**
80 watt **$350**
100 watt . . . **$399**
120 watt . . . **$499**
160 watt . . . **$599**
200 watt . . . **$699**

Complete DVR CCTV PACK

IR Indoor/Outdoor Cameras

4 Cameras & DVR Kit **$369**

8 Cameras & DVR Kit **$799**

Also 16 ch DVR and Cameras

FISH FINDER!

Complete easy-to-use kit tells you where the fish are!

ONLY $99

Infomon Wind Turbines

One of the most technologically advanced Wind Tubines on the market. Sold in over 70 countries across the world!!! We have 2 models to choose from:

Portable 500W Wind Turbine kit - complete with controller and tower for fast easy set up

SALE

Was $1599 **NOW ONLY $699**

For those who want to generate some serious power we have a 1000 watt system complete kit with stand and controller

Dont Pay over $2000

SALE $1199

LIMITED STOCK

HUGE POWERFUL Infomon Generator

SALE

25KVA **$4999**
50KVA **$8888**
120KVA . . . **$10999**

Stainless Steel Cooktop

60cm, 4 burner gas with auto ignition

JUST $99

And Stove

60cm electric fan-forced oven with temperature, timer control

AMAZING $299

REVERSE CAMERA KIT

Includes cable, 7" LCD monitor PLUS Camera

ONLY $169

5/110 Station Rd, Seven Hills NSW 2147 (Mon-Fri 9am-5pm)
Phone (02) 9620 9011 www.lhp.net.au

GREAT PRICES

The way it should be!

BENCH GRINDERS
- 240V motor
- Fitted with eye shields & tool rests

150mm **$99** (G150)

200mm **$139** (G159)

SAFETY SPECS
- Clear indoor use
- U.V. protection
- Hard-coat anti-scratch lens

$11 (W105)

- Vector smoke outdoor use
- U.V. protection
- Hard-coat anti-scratch lens

$11 (W106)

FACE SHIELD
- Clear viewing window
- Rachet style size adjustment knob for quick and easy size adjustment

$23 (W102)

AIR ACCESSORY KIT
- Spray gun gravity type
- Degreasing gun with pot - long nozzle
- Tyre inflator with gauge
- Dusting gun with self coil hose

$35 (B445)

36L COMPRESSOR
- 36 litre tank
- 2.75hp motor
- 205L/min free air delivery
- V-Twin pump

FREE Air Hose (H008)

$429 (C327)

TAP & DIE SET 32 PIECE
- Range: M3 - M12

Carbon Steel **$49** (T012)

HSS **$109** (T013)

BENCH VICES
- Offset fabricated
- 150mm jaw width

$119 (V067)

- Multi-purpose
- 125mm jaw width
- Swivel head & base
- Includes anvil & pipe jaws

$159 (V074)

WORKSHOP DRILL SET
- 170 Piece 1-10mm • HSS

$139 (D126)

SBD-25A DRILLING MACHINES
- 20mm drill capacity
- 1hp 240V motor
- Micro switch on belt cover
- Includes safety drilling chuck guard, 16mm drill chuck, arbor & light
- 16-speed

FREE VICE (V124)

BENCH MODEL **$339** (D144)

PEDESTAL MODEL **$369** (D147)

TOOL CHEST & ROLLER CABINET

6 Drawer Tool Chest **$99** (T602)
- Lockable by key
- Ball bearing slides

5 Drawer Roller Cabinet **$198** (T705)
- Lockable by key
- Ball bearing slides

PACKAGE PRICE (T0690 + T0695) **ONLY $279**

SOLID CARBIDE BURR SET 5 PIECE
- Double cut
- 3/8" & 1/2" sizes
- Industrial quality
- 1/4" shanks

$79 (B900)

RATCHET TAP WRENCHES
- Forward/reverse operation & lock
- Designed for use with taps reamers screw extractors & other tools with a square shank

No.1 M3-M10 **$14** (T693)

No.2 M5-M12 **$18** (T861)

INDUSTRIAL WET & DRY VACUUM CLEANER
INCLUDES:
- 1 brush
- 1 dry floor nozzle
- 1 crevice tool
- 1 wet floor nozzle

30L, 1000W, 240V **$189** (V503)

THREAD GAUGE
- 28 Whitworth (4-62 tpi)
- 24 Metric (0.25-6 pitch)

$14 (70-810)

FEELER GAUGE
0.03 - 1.0mm

$16 (70-616)

SPRING CALIPERS

Dividers **$9** (QE634)

Inside **$9** (QE635)

Outside **$9** (QE636)

HEX KEY SETS
- Flip open design
- Extra long ball end hex keys
- Ball head design allows turning of hand to reach fasteners
- 9 piece

IMPERIAL 1/16"-3/8" **$18** (H800)

METRIC 1.5-10mm **$18** (H801)

SECOND CUT FILE SET 5 Piece - 200mm
- Cushion grip handles
- Flat, round, 1/2 round, square & triangular

$29 (F100)

AL-60M LATHE MILL DRILL

Lathe
- Ideal for small workshops
- Precision ground 'V' Bed
- Heavy duty A-section belt drive
- 550W induction lathe motor with reversing switch
- Powered long feed and thread cutting capabilities
- Rear splash tray is standard
- Sheet metal leadscrew cover
- Hinged belt cover with safety micro switch
- Chuck guard with safety micro switch
- Ball bearing oiling points
- Easy access fuse cover
- Adjustable cross and compound slide gibb keys

Mill
- Supplied with a small ground and slotted milling table which attaches to the compound slide
- Head tilts ±45°
- 2-speed gearbox for increased torque
- 350W electronic variable-speed controlled motor
- Slides utilise dovetail construction for maximum rigidity

HOT PRICE

$1,895 (K160)

FREE BOOK (L341)

PUNCH SETS

3/16" Letter **$39** (P350)

3/16" Number **$18** (P351)

5/16" Letter **$49** (P354)

5/16" Number **$22** (P355)

BENCH VICES - Cast Steel

SIZE	
100mm	**$59** (V088)
125mm	**$94** (V089)
150mm	**$129** (V090)

Specifications & Prices are subject to change without notification. All prices include G.S.T. and valid until 27-08-11

HARE&FORBES MACHINERYHOUSE

www.machineryhouse.com.au

Sydney: Northmead Ph: (02) 9890 9111
Melbourne: Dandenong Ph: (03) 9212 4422
Brisbane: Coopers Plains Ph: (07) 3274 4222
Perth: Belmont Ph: (08) 9373 9999

6.11_2707